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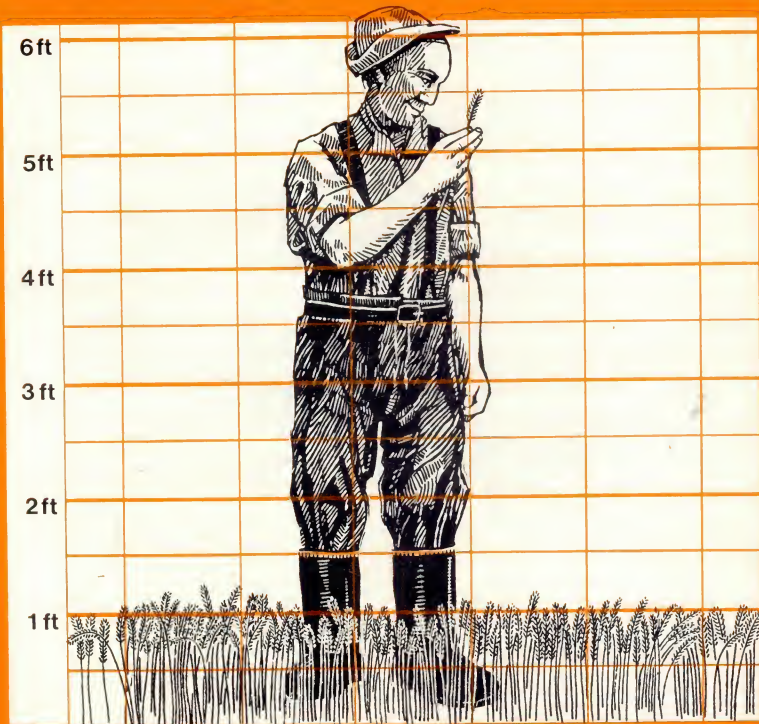
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This One



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Comment

Destruction capability modified

In past weeks, James Schlesinger, the US Defense Secretary, has been publicly expounding the future directions of American strategic nuclear policy. His initial statement referred to a modification of the Macnamara doctrine of "Mutual Assured Destruction Capability", which meant that the US "must maintain a highly reliable ability to inflict an unacceptable degree of damage upon any single aggressor or combination of aggressors at any time during a strategic nuclear exchange, even after absorbing a surprising first attack". In future, as well as being aimed at Soviet cities, US strategic land and sea based missiles will be aimed at military targets referred to as "hard sites" because they are often defended by anti-ballistic missiles (ABM). Previously this was technically very difficult.

The new Multiple and independently Re-targetable Vehicle (MARV), designed for the new US Trident missile submarine, provides for corrections throughout the sub-orbital trajectory of the warhead and can be aimed directly at Soviet missile silos. This post-boost control also enables the warheads to arrive on target from individual and quite different trajectories which, with the addition of decoy warheads, makes their destruction by ABMs very difficult. The United States has had a grossly over built nuclear arsenal for several years, and the surplus missiles were already targeted at "hard sites" though their accuracy was in question. The new degree of accuracy and penetrability of MARVed missiles and the change in US strategic policy thus provides America with the capability of a pre-emptive first strike against a nuclear opponent.

The only safeguard against a pre-emptive first strike

is the missile submarine, which is relatively invulnerable and of which the American is superior to the Soviet model. Because of the small number of missile submarines that the Russians have on station at any one time, and because their missiles have only single warheads, they are vulnerable to the US Safeguard-Sentinel ABM system. This can distinguish between real warheads and decoys in real-time, and has been successfully tested knocking out three warheads at a go.

By comparison, Soviet developments do not justify the recent American moves, which Schlesinger hopes will provide President Nixon with more than one option in the event of a nuclear war. The Russians have recently shown the ability to "cold launch" their ICBMs from their silos on a pocket of compressed air—in principle, similar to submarine launches. The advantage of this method of launching is that it can increase slightly the range and warhead yield of the missile by effectively making it lighter at launch.

As the recent Nixon/Brezhnev agreements provide for consultation over nuclear strategy, there has presumably been agreement over each others' future strategic nuclear policy and that the present parade of up and coming American nuclear weapons are "bargaining chips" for SALT 2 round of talks. At the moment, US nuclear policy for Europe and America's control of Britain's Polaris fleet should be cause for greater concern, for while we implicitly subscribe to American nuclear strategy, we have no idea what is really going on between Nixon and Brezhnev.

Farooq Hussain

Field mice nibble holes in pesticide ban

Autumn-sown dressed grain can pass on enough dieldrin to kill both field mice and the owls and hawks which prey on them, according to a recent study from Monks Wood. These results reveal a serious loophole in the present "voluntary" arrangements between government, farmers and the agrochemical industry for restricting organochlorine pesticides in Britain, and are bound to lead to renewed pressure for a more effective control system backed by law.

It has been a common procedure since the 1950s to "dress" cereal seed (dunk it in a liquid or powder) with an organochlorine insecticide for protection against wheat bulb flies and wireworms. In 1962 the dressing of spring-sown grain was totally banned (in the sense that farming leaders and pesticide companies agreed to discourage it). At the same time the practice was severely limited for autumn-sown winter wheat, being allowed only in areas and in seasons when the Ministry of Agriculture considered there was no serious danger from wheat bulb fly. It was then considered that in autumn, when food is generally more plentiful than in spring, and when animal populations are larger and thus better able to withstand mortality, the risk-benefit equation was tilted in favour of continued use. This assumption must now be seriously questioned.

Dr Donald Jefferies, Bruce Stainsby and Michael French from Monks Wood experimental station (of the Nature Conservancy when the work was done, but now trans-

mogrified into the Institute of Terrestrial Ecology) examined mice and voles before and after wheat dressed with dieldrin was sown on a field in the fens near Huntingdon on 3 December 1969. The main mammals feeding on grain left on or just below the surface were long-tailed field mouse (*Apodemus*). In the fortnight before seed was sown, these were found to contain an average of 2.5 microgrammes of dieldrin, while in the two weeks following sowing the mice carried 167 microgrammes: nearly 70 times more. These were well over the lethal level, and some mice certainly died from dieldrin poisoning; it seems feasible that during the winter the whole of the initial mice population in the field was wiped out.

Ecologically, however, this is unlikely to have caused more than a local population imbalance, as there is always severe winter mortality among field mice and their numbers would quickly recover in spring. What gives rise to more concern is the effect on animals higher up the food chains. During the winter, barn owls, kestrels and (near woodland) tawny owls all feed on field mice, and in this fenland field they could have picked up as much as 298 microgrammes of dieldrin from one mouse. A kestrel in the laboratory died after being fed over a week with seven voles containing no more dieldrin than the average mouse in this field after sowing. Moreover, in the wild a predator's attention would be drawn to the most heavily-dosed mice, by the unusual behaviour

(running backwards and squeaking loudly) which they are known to exhibit.

Since the voluntary "ban" on autumn-dressed wheat, the spectacular kills of seed-eating birds like woodpeckers which characterised the British farming scene in the late 1950s have disappeared. Dr Jefferies and his colleagues now warn that this improvement may have "hidden a continuing mortality among barn owls and kestrels", suggesting that the continued use of grain dressed with persistent organochlorines could be reducing total populations of these important predators on farmland pests.

Following the recommendations of the Cook Committee in 1967, the government promised to introduce legislation

to make the voluntary pesticide restrictions compulsory, and a draft Bill was prepared by the Ministry of Agriculture. This Bill has now been abandoned, to the regret of conservationists and the delight of the tearaway element in the agrochemical industry. The Monks Wood results must now raise once again the whole question of whether the cumbersome processes of reaching voluntary agreement on pesticides are adequate to protect our environment. There are likely to be renewed demands for a legal backup to a scheme which can do nothing to prevent evasions by individual farmers, and in particular, for a ban on organochlorine dressings of winter wheat in time for the autumn of 1974.

Jon Tinker

Manpower and moneypower

Two distinguished manpower planning specialists have put together a report* on the use of computers in manpower planning which identifies a dilemma. Clearly, their main task is to underline the national need for manpower knowledge. The Robbins report is exhumed to great effect to highlight the uncertain interaction between the educational system and the labour market. If industry's needs are known, the report implies, the educational payoff can be raised. So they regard the devil of national computer systems storing personal data as inevitable, to chart the deep blue sea of manpower. Integrated national systems which create a network of data banks based on individual records and "citizen numbers" are seen as something that "will occur to some degree and in one form or another. Some such system will develop in most countries, whether we like it or not".

Unfortunately, the OECD authors succeed in conveying an impression of concern for public liberties and individual privacy which rates a lower priority than the technical urgencies and fascinations. They admit that it is in the "nature of experts" to leave political and human issues

* The Development of Electronic Data Processing in Manpower Areas, OECD.

to one side "while concentrating on the interesting technical challenges involved". The only justification for this attitude seems to lie in a belief that the safeguarding of public values is a much simpler problem than that of implementing computer based systems.

However, the material culled from eight major European organisations in the report shows a determination to build computer-based personnel information systems backed by the immense resources of Philips, Siemens, Ford, Esso, and the Civil Service Department, for instance, while the resources devoted to safeguarding the public are unlisted. They will remain unlisted for the simple reason that no significant funds have been devoted to protecting the individual. Part-time groups of the British Computer Society are no match for the data processing budgets of governments and industrial giants.

The "nature of experts" is that they have influence. Let them use their influence to provide equal funds for the study of computer privacy and security questions, before they return to the task of building the integrated network of computer personnel systems for which they so stridently plead.

Hedley Voysey

A questionable questionnaire

By now the results of the official questionnaire circulating round the British Patent Office last December (New Scientist, vol 60, p 883) should be on Sir Geoffrey Howe's desk. If he has looked closely at them, they could already be in his wastepaper basket, for the questionnaire was so worded as inevitably to produce worthless results. The crucial question required Patent Examiners to answer by name whether they were "positively inclined to go" or "not prepared to go" to Munich in three or four years' time to work in the European Patent Office. Astonishingly, bearing in mind all the ifs and buts attached to such a question, there was no option for a "don't know" or "undecided" answer. Virtually the full complement of examiners (515) answered the question and of these 179 (35 per cent) said they would go, while 336 (65 per cent) said they would not go. Given the way the question was worded, it is very surprising indeed that so many people stepped out of line at this early stage. For many examiners have a nagging feeling that to show their true anti-Munich feelings too early may endanger their chances of current promotion. They also fear that if they veto Munich at this stage, they will not be included in any training schemes, and will have no chance to say "yes" at the last minute.

On the other hand, some far-sighted examiners believe that if they plump now for a Munich transfer, and receive language and European law training over the

next few years, they will find themselves in a decidedly sticky position if they then say "no" at the last minute. All this and more adds up to the obvious need for a "don't know" or "undecided" option on the questionnaire and makes the Yes/No figures utterly meaningless.

An unofficial questionnaire circulated round the Patent Office and requiring no name or signature was more sensibly worded. It was completed by 459 examiners (doubtless some of the more senior men committed to making Munich-work-at-all-costs declined to cooperate). Of these, 244 (53 per cent) said they had no intention of transferring to Munich; 178 (39 per cent) gave the undecided answer, which they had been unable to give on the official questionnaire; and 37 (a measly 8 per cent) confirmed that they actually intended to transfer to the EPO.

It is no secret that Comments such as this one in New Scientist are despised by some upper echelons of the Patent Office and DTI as they are seen as part of an ill considered attempt at sabotaging the European system before it even begins. But what could be more effective sabotage than to produce impressive sounding figures on the British staffing of the Munich office which are blatantly unreal and which, if relied on in good faith, could guide well-meaning politicians into decisions which they would not otherwise have taken?

Adrian Hope

Monitor

A first glimpse of Mercury's topography

Until the Mariner-Venus-Mercury spacecraft performs its fly-by programmed for 29 March, we shall not really know what Mercury's surface looks like. Few features show up in a telescope, and the best information comes from radar experiments. In recent years CalTech's Jet Propulsion Laboratory has been the fore-runner here. But, even with radar, it has hitherto been possible to distinguish only some "continent-sized" rougher patches on the planet's surface. Now two JPL astronomers, Drs Richard Goldstein and Shalhav Zohar, report in the current *Astronomical Journal* that they have picked up radar echoes revealing Mer-

curian hills and valleys with a height difference of about one kilometre. Signals reflected from several areas seem to indicate craters about 50 km in diameter and some 700 m deep.

The JPL workers made the observations in the latter part of 1972, using a 64-m dish at NASA's Goldstone Deep Space Station in California. The radar pulses were transmitted with a power of 400 kW at a wavelength of 12.5 cm. Signals bounced off Mercury made the 110-million-mile round trip in about 10 minutes. The complete experiment included 14 radar probes along an equatorial band on Mercury lying between

latitudes 12°N and 4°S. Each of the 14 took in an area some 600 km across.

According to Goldstein, leader of the JPL team, there is also some evidence among the newly analysed data, for much bigger craters up to 500 km in diameter—although the researchers are none too happy about the existence of these features. The hills, they say, are of low slope or gently undulating. One feature, described as a "promontory" rises 1300 m from a base 120 km wide.

Mercury's diameter is 3100 miles and it has only 0.06 of the Earth's volume. It orbits the Sun at a distance of 36 million miles so that the daytime temperature is very hot—probably in the region of 400°C. Because the atmosphere is extremely tenuous, however, the four-week-long nights must be savagely cold.

Now, molecular messengers can copy themselves to prolong their life

It used to be that a cell only needed a couple of nucleic acid synthesising enzymes: one to make new DNA from old, and another to copy DNA into RNA. That was it as far as molecular biologists were concerned; the two enzyme activities did all that was necessary in the known scheme of things. Then in 1970 came the bombshell of a third enzyme, one that could make DNA in the image of RNA. The independent discovery by Howard Temin and David Baltimore of this "RNA-dependent DNA polymerase" revolutionised molecular biology, posing a theoretical challenge and providing an immensely useful new practical research tool, particularly in cancer research. Now comes another surprise, not as shattering as that of Temin's and Baltimore's, but very important nonetheless: there appears to exist a fourth nucleic acid synthesising enzyme in mammalian cells, this time an RNA-dependent RNA polymerase, capable of replicating messenger RNA molecules.

Diagrammatically, the situation was once as follows, the arrows representing the transfer of information in enzymically controlled reactions:



Temin and Baltimore added a third arrow:



and now Kathleen Downey and her colleagues at the University of Miami have made the scheme symmetrical:



Their work, reported in *PNAS* (vol 70, p 3400), has considerable theoretic-

cal importance if it is confirmed and generalised, for the enzyme adds another dimension to genetic regulation. When the role of messenger RNA in protein synthesis was first clarified over a decade ago, a key point was that messenger RNA is short-lived: once it stops being made, it soon disappears. And so indeed is the case for bacterial systems such as those in which messenger was first discovered. But there is now abundant evidence that messenger RNA in the cells of higher organisms can persist long after it is synthesised. One of the best-studied systems involves reticulocytes, immature red blood cells that have lost their nucleus yet actively synthesise haemoglobin. Because the cell has no DNA it cannot be making new messenger RNA, yet the continued haemoglobin synthesis demonstrates that haemoglobin messenger RNA molecules must be alive and well. The usual interpretation is that the messenger RNA is stable, and indeed the plethora of test-tube translations of mammalian messenger RNA molecules attests to this. But it could be also that messenger RNA levels are maintained by the synthesis of new molecules using the existing messengers as templates. It is this reaction that Dr Downey and her colleagues now claim to have found occurring in duck reticulocytes.

There is nothing intrinsically odd about the reaction itself: RNA viruses use their RNA for directing protein synthesis, and as a template for new RNA production, all the time. The oddity is finding the reaction in a mammalian system. The Downey paper has some interesting speculation about the enzyme's role. They suggest, for instance, that the enzyme might provide a mechanism for "amplifying" genes: in cells that make a lot of one kind of protein a single gene could produce thousands of copies of messenger RNA if the messenger were able to replicate itself.

More of life's origins come to Earth

American space scientists have uncovered yet another glimpse of prebiotic evolution: they have detected certain types of fatty molecules in two meteorites that already have provided biologists with valuable information about the creation of life from inorganic matter.

Exobiologists—the scientists interested in the creation of life in space—have been delving into the Murray and Murchison meteorites for some years now in search of clues for the beginnings of life on earth. During 1970 and 1971 NASA scientists discovered amino acids—the building blocks of proteins—in these two immigrants from space. And towards the end of 1971 the same scientists, at the Chemical Evolution Laboratory in California, found pyrimidines—molecules that form part of the backbone of nucleic acids—in a third meteorite, Orgueil. But Murray and Murchison are now back in the news because they have been found to contain fatty acids, important structural components of all types of living cells.

Keith Kvenvolden, chief of the Chemical Evolution Branch at Ames, and George Yuen have been using sensitive analytical techniques such as gas chromatography to tease out the chemical secrets of Murray and Murchison. They have now come up with 17 different fatty acids, the first time such molecules have been found in inorganic materials like the rocky meteorites.

It seems very unlikely that essentially "biological" molecules like these actually derived from living organisms in space. A more probable explanation is that they were created in "extraterrestrial chemical cauldrons", just like the amino acids and pyrimidines are thought to be. That being so, yet another detail of the blueprint for life on earth has been provided from these rocky immigrants to our planet.

Factors in a co-carcinogenic world

A disheartening catalogue of tests in animals and test tubes has shown how various agents which may be relatively innocuous on their own can conspire with other agents to cause cancer. In this way, chemicals may act as co-carcinogens for other chemicals, viruses for other viruses, and chemicals for viruses. Now another epidemiological study on man himself has thrown up a suggestive bundle of factors associated with lung cancer. The message this time (*Science*, vol 185, p 210), is, if you are a man, do not both work in industrialised Los Angeles and smoke.

The association between lung cancer and smoking is of course already well established. But there must be an explanation for the fact that although more people who smoke heavily fall victim to the disease than do non-smokers, it is nonetheless possible for a lifelong chain-smoker to escape scot-free. Obviously there must be predisposing or interacting factors besides cigarette smoke. Herman Menck and a couple of colleagues, who have been putting some figures together in the impure air of Los Angeles, think one of them may well be benzo[a]pyrene—produced by industry and also by car exhausts.

Benzo[a]pyrene has fallen under suspicion before in the aetiology of lung cancer associated with smoking. Menck with his collaborators John Casagrande and Brian Henderson, compared lung cancer mortality rates with air and soil content of polynuclear aromatic hydrocarbons (the family to which benzo[a]pyrene belongs) in 13 different areas of Los Angeles.

The death rate for white males over a two-year period varied between 43 and 75 per 100 000; but three neighbouring areas stood out as having mortality rates in the 70s. In the middle of these three areas lay the sampling station which, in a survey during 1970 and 1971, reported the highest environmental levels of benzo[a]pyrene.

The difference in mortality rate did not appear in the statistics on an equivalent sample of women; nor could the same geographical clustering be discerned for other kinds of cancer. Menck and his colleagues therefore tentatively conclude that lung cancer is caused by the synergistic action of cigarette smoke and benzo[a]pyrene produced by the local petroleum and chemical industries in which the men work.

West Antarctica's ice may be wasting away

In round figures, if the whole Antarctic ice cap were suddenly to melt, sea level all over the world would rise about 100 ft. Such a violent catastrophe is, fortunately, unlikely. But a recent analysis of the past history and present behaviour of that part of the Antarctic ice-cap covering West Antarctica strongly implies that the huge glacial sheet there is no longer in equilibrium and is probably disintegrating at this moment. Were it to do so completely the sea level would rise some four metres (*Journal of Geophysical Research*, vol 78, p 7884).

T. Hughes of the Institute for Polar Studies, Ohio State University, who makes this deduction, points out that West Antarctica, largely comprised of Marie Byrd Land, differs from the much larger eastern section of the continent in that most of its ice sheet drains into the sea via two large ice shelves. Unlike the East Antarctic ice shelf which "grounds" above sea level, that of the West Antarctic "grounds" below the sea at points where the floating ice takes off to form the Ronne and Ross ice shelves. A number of factors, including quite moderate warming of the climate, the release of brine pockets trapped at the base of the ice, and suitable conditions for thermal convection, can combine to produce sudden surges in the ice streams draining Marie Byrd Land.

Whatever the mechanisms involved, the exhaustive treatment to which Hughes subjects a large and diverse wealth of Antarctic data, firmly indicates that the ice sheet of this part of Antarctica is wasting away considerably faster than it is being replenished.

Streams of faster moving ice, says Hughes, can be traced from the crevasse fields of Marie Byrd Land, and by "elongated lobes of thick ice" across the Ross ice shelf. Former extensions seem to be reflected in troughs eroded in the sea floor of the continental shelf.

Hughes summons seven lines of evidence pointing to non-equilibrium of the ice sheet: The ice surface has a concave profile, whereas ice sheets in equilibrium have a convex profile. Six glacial advances and retreats recorded during the past 7-0 million years add up on balance to an overall retreat of the ice. The bedrock beneath the floating ice, at least, is apparently rising due to isostatic readjustment following the removal of ice. Oxygen isotope analysis implies that the ice inland was formerly several hundred metres higher. Between Byrd Station and the ice "watershed" ice flow exceeds precipitation. And the two observations of thermal instability, and the presence of water at the ice base, are both preconditions for surges.

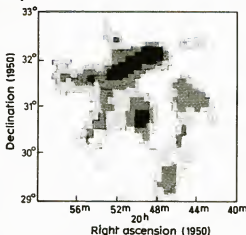
Taken together the data suggest that, in the last 4000 years the ice has reduced in thickness some 300 to 500 m at Byrd station, losing $1\frac{1}{2}$ million cubic km of ice and increasing sea level 3 to $3\frac{1}{2}$ m. The "grounding line" beneath the Ross shelf has retreated at about 70 m/year over the past 10 000 years, but during the last 1000 years this rate seems to have stepped up to around 300 m/year.

A central object in the Cygnus Loop

Current theory suggests that pulsars and neutron stars are born as a result of supernova explosions. However, few supernova remnants have associated pulsars, as does the Crab Nebula, and astronomers welcome further candidates. The Cygnus Loop, sometimes known as the Veil Nebula, is a typical supernova shell, which until now apparently lacked any stellar remnant. Its filamentary nebulosities define a rough ring in the sky, similar to the loop structure familiar to radio astronomers. Unsuccessful searches have been made in its central regions at those wavelengths but, since the supernova may have occurred some 50 000 years ago, any asymmetry in the explosion could by now have ejected a pulsar right out of the Loop itself.

The last three years have seen X-ray astronomers active in using relatively crude imaging devices on the Cygnus Loop. It is ideal for rocket astronomers in some respects, since its large extent (3°) and high surface brightness in soft X-rays enable simple one-dimensional X-ray telescopes to map its emission. Several scans across the Loop at different angles can be obtained within the few minutes afforded by a rocket flight, yielding a map after the application of some reconstruction technique.

Drs S. Rappaport, W. Cash, R. Döxsey and G. Moore of the Massachusetts Institute of Technology, with R. Borken of the University of Wisconsin, present the latest of such maps of the Loop in *Astrophysical Journal* (vol 186, p L115). Their plot reveals the presence of a central "hot spot" giving 4 per cent of the total emission. The spot is quite obvious in their higher energy channel and it is evidently a neutron star at a temperature



This X-ray intensity contour map, for radiation of energy between 0.4 and 0.85 keV, clearly reveals a central "high" in the Cygnus Loop

of six million degrees. They have analysed these X-ray data for pulsations and a 62-millisecond period appears, although not very significantly.

This newly detected "hot spot" could well be variable in its X-ray output. Further work is necessary both to look for this variability and also, at higher resolution, to see how small it really is. More conventional X-ray telescopes may be necessary for this task. The relatively greater surface brightness of the Loop's central region make it a good target for satellite X-ray telescopes which, although they lack the collecting area of rocket devices, offer far better resolution and longer observing time.

Pegging the biochemistry of George III's disorder

Research into metabolic diseases has often made progress through the use of drugs to produce in experimental animals a condition corresponding to the human disease state. For example, the detailed metabolic disturbances associated with diabetes in humans have been clarified because the drug, alloxan, generates a diabetic state in rats.

Recently, several papers have appeared which strongly suggest that the use of chemical inducers of the "porphyrias" will soon clarify some puzzling aspects of these diseases and may even point to a treatment. The porphyrias are a group of conditions in which there is some disorder in the metabolism of porphyrins, the large organic molecules which are found combined with iron in haemoglobin and many important enzymes. Excessive synthesis of the porphyrins leads to their excretion in the urine, so that the urine of porphyric patients is strongly discoloured; owing to the chemical reactivity of the compounds it may even change colour on standing. This alarming visible manifestation caused the disease to be recognised and described a long time before it could be interpreted chemically. It was found to be hereditary and it afflicted several members of the Hanoverian royal family. About 25 per cent of patients with a disease of the porphyria type show mental as well as physical symptoms, and it is probable that George III's fits of "madness" were, in fact, manifestations of porphyria.

Now, confronted by a porphyric patient we can do a clinical classification of the disease and a genetic tracing of its origin. But we lag a long way behind in our understanding of the underlying biochemical fault. We don't even know how (or whether) the excessive levels of porphyrins and their precursors lead to the other physical and mental symptoms. This is where drug-induced porphyria in rats may be useful. Using this "model" disease, a group at the Toxicology Center of the University of Iowa has worked out a promising biochemical treatment which reduces porphyrin synthesis (W. N. Piper, L. W. Condie and T. R. Tephly, Archives of Bio-

chemistry and Biophysics, vol 159, p 671). And workers at the Addiction Unit of Whitechurch Hospital, Cardiff, have explored the connection between disorders of porphyrin metabolism and mental disturbance (A. A. Badawy and M. Evans, Biochemical Journal, vol 136, p 885).

Tephly's group at Iowa approached the treatment of porphyria from a highly theoretical viewpoint. If the porphyrias arise from over-production of porphyrins and their immediate precursors then, to reverse, this one must find a way of deflecting some early precursor so that there is only a limited amount of it available. Bearing in mind that the key step in making porphyrins, the synthesis of δ -amino-laevulinic acid or ALA (Figure 1) occurs mainly in the mitochondria of liver cells, the Iowa group concentrated on another enzyme which is present in high levels in the same place. This enzyme, glycine acyltransferase, is relevant because it catalyses a reaction of glycine, a metabolite which is also used in the synthesis of ALA (Figure 1).

In theory, if glycine can somehow be tapped off by the glycine acyltransferase reaction, the amount available for the synthesis of ALA will fall and this should cause a reduction in the synthesis of porphyrins. So Tephly and his colleagues generated porphyria in their rats using a drug called DDC, and then treated the rats with benzoic acid or p-amino-benzoic acid which should combine with glycine in a reaction catalysed by glycine acyltransferase. The effects of these treatments were dramatic. The levels of porphyrins in the tissues and blood, which had been raised by DDC, were halved. The levels of porphyrin precursors in the urine, which had been increased ten-fold, were returned almost to normal.

The Iowa group went on to make certain that these effects arose in the way they assumed. They showed that if glycine was added as well as benzoic acid, there was no reduction in porphyrin levels, and they showed that hippuric acid, the product of the combination of glycine and benzoic acid, has no effect in itself. The reversal of experimental porphyria must, there-

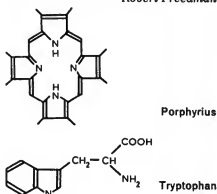
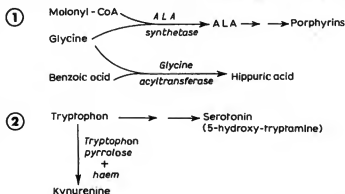
fore, have arisen from the deflection of the precursor, glycine, into an alternative pathway. But what this clever experiment cannot show is whether benzoic acid or p-amino benzoic acid will be effective in treating human porphyria. As the authors point out, "These agents are effective in reversing the elevations in heme precursors seen in experimental porphyrias. However, there is no proof that these precursors, themselves, are responsible for the toxic syndromes associated with the various types of human porphyrias."

One of these "toxic syndromes" is what used to be called madness and is now more specifically described as "mood disorder". It is not known how this arises, but Abjulla Badawy and Myrdin Evans at Cardiff have suggested that it may be connected with porphyria through the metabolism of the amino acid tryptophan. This compound is broken down by a number of different routes, one of which produces serotonin, which is important in the brain and is associated with mood. Another pathway of tryptophan metabolism is catalysed by the enzyme tryptophan pyrrolase, and it has been found that high tryptophan pyrrolase activity in the liver leads to low levels of brain serotonin and vice versa (see Figure 2).

The question therefore was "Does porphyria affect liver tryptophan pyrrolase activity?" Two facts suggest that it might. Firstly, some patients with porphyria excrete large amounts of the breakdown products of kynurenine, which is itself produced by tryptophan pyrrolase. Secondly, tryptophan pyrrolase requires for its action the cofactor haem, which consists of an iron atom plus porphyrin.

These suggestions are not proof, and Badawy and Evans have begun studies on tryptophan metabolism in rats with experimentally-induced porphyria. These studies are at an early stage, but already show that treatments affecting porphyrin metabolism do cause changes in the level and activity of tryptophan pyrrolase. So some connection between porphyrin and tryptophan metabolism is established, but it will require much more work to discover if this is the route by which porphyria causes mental disturbance.

Robert Freedman



Glomar Challenger data weakens hot spot theory

In an attempt to explain the thorny problem posed by the existence of mid-Pacific volcanic islands far from active ocean ridges, oceanographers have recently proposed a "hot spot" theory. The idea was based upon a number of allegedly fixed, sub-crustal regions of exceptionally high heat flow. As the sea-floor spread across these areas volcanic scars were "burned" through it, leaving the familiar chains of oceanic islands. Now, however, samples drilled from some of these areas by the Deep Sea Drilling Project's ship Glomar Challenger, provide evidence militating against this imaginative hypothesis.

During the ship's Leg 33, which began in Honolulu and ended last month at Papeete, Tahiti, the drillers sampled the sea floor at sites along the Line Islands. According to the hot spot theory, clearly those islands farthest from the present site of the proposed hot spot should be the oldest. However, basalts cored from places near Fanning and Christmas Islands, close to the middle and southern end, respectively, of the island chain, indicate that the volcanic activity ended at each some 80 to 85 million years ago.

Samples taken from a site at the northern end of the Line Islands on an earlier leg of DSDP, gave essentially the same result. The progressive age tendency which the theory predicts is thus absent.

Sizing up molecules with three kinds of scattering

Tyndall's observation in 1871 indicated that scattered light from a gold sol could give information about the particle sizes. It opened up many avenues in scattering phenomena, most notably that of the Raman effect, now much used in vibrational spectroscopy. Today physicists employ scattering methods of diverse kinds. Light is scattered by "bound" electrons; X-rays by "free" electrons; and neutrons by atomic nuclei. A new application of all three of these scattering phenomena has recently been suggested by I. N. Serdyuk and B. A. Fedorov of the Institute for Protein Research, Poustchino, USSR. The technique has relevance to the plastics industry, and could also be of enormous importance in the study of biological macromolecules with one type of polymeric structure.

Writing in the *Journal of Polymer Science, Polymer Letters Edition* (vol 11, p 645) these chemists show how new information on the structure of molecules in solution can be gleaned from the joint application of light, neutron and X-ray scattering. The study is novel because to extract structural data researchers must analyse the results of dynamic scattering, from molecules in motion in the solution; whereas in solid-state studies the scattered radiation is reflected from rigid crystal lattices.

Studying a hypothetical two-component block copolymer system, the Poustchino workers first provide a theoretical link-up between the three types of scattering. The equations developed by Serdyuk and Fedorov allow a value for the "electronic radius of gyration" (the volume swept out by the molecule moving around) to be calculated. They have tested their theory with results obtained for the copolymer styrene-methylmethacrylate in dilute solutions of dioxane and benzene. From these they were able to calculate the total length of the block copolymer and also the lengths of the two components, because the different portions scatter the impinging radiation to different extents.

Testing the girders of a submicron silica bridge

Very thin rugged films of oxides, grown on silicon and some metals, can serve as protective coatings, for example, as in anodised coatings on aluminium or the insulating separators used widely in silicon integrated circuits. Because they are so thin—literally thinner than a bee's wing and possessing the same iridescence—it is very difficult to study the chemistry and physics of these films properly. We do not know, for instance, how far we can compare the grown silicon dioxide films to fused silica with respect to the type of bonds present or the type of bond breakage which can occur when the film is excited by irradiation. While physicists can, with effort, etch the silicon backing away from the oxide, the remaining films are then difficult to handle. Two investigators from GEC Research and Development Laboratory, Schenectady, R. A. Sigbee and R. H. Wilson, have now found a way of measuring mechanical strain and oxide volume changes in a self-supported silica bridge only 0.5 micrometre thick. The handling problem is neatly solved because the film is still attached to the parent silicon at each end of the bridge.

The method for making the bridge and for calculating mechanical stresses was actually developed earlier by S. Lin and I. Pugacz-Muraskiewicz of IBM. They formed a thin film of silicon dioxide, ranging from 0.02 to 1 micrometre thick on a polished silicon surface by the usual oxidation

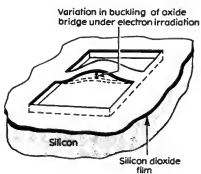
techniques. They then etched two moats side by side, penetrating the oxide and leaving a strip of untouched oxide between them. A second etching solution then undercut the silicon from each side. Eventually, the strip of oxide was freed, but was still connected at each end to the unaffected oxide, which was of course, attached to the silicon. Lin and his co-worker found that the freed oxide strip formed a curved bridge because it had been under a compressive stress of up to 10^9 dynes per sq.cm as grown on the silicon. The two GEC authors have now taken this method a step further into physics.

A simple measurement of the interference fringes formed between the bottom surface of the bridge and the silicon beneath can give a very exact measure of the curvature of the bridge and hence also of changes of curvature under further processing. These changes can, in turn, be interpreted in terms of physical processes occurring in the film. We thus have a new

physical handle on the behaviour of the material. One of the processes which produces changes of volume in silica is irradiation with high-energy particles or photons. This process has been studied in thick pieces of fused silica but it has not been easy to determine whether the changes were due to simple bond breakage (ionisation effects) or the complete removal of atoms from their sites in the network (displacement effects). With a thin film, one can use particles with energies which are too low to produce displacements.

Writing in *Applied Physics Letters* (vol 23, p 541), Sigbee and Wilson report that irradiation of the curved silica bridges with a beam of kilovolt electrons produces a gradual reduction in the curvature of the film, indicating a contraction. This is the same direction as that observed in solid fused silica irradiated by 3-MeV electrons, but the effect is not so great in the present case. This is a good indication that they are here observing only one process, the ionisation effect, rather than the two effects caused by the very energetic 3-MeV particles. The idea is borne out by the ease with which the effect can be reversed by heating. We can apparently make and break the girders, or bonds, in this silica bridge at will.

With methods like these, unconventional but necessary for the study of thin films, it may be possible to build up a picture of the physical nature of the films which will help us to use them even more effectively in microelectronics, optics and corrosion prevention.



Towards super cereals

Within a decade, British wheat may stand a mere 12 inches high, due to the introduction of dwarf, high-yield strains. Current genetic studies on hormone activity in such varieties could lead to the emergence of the new "super cereals" of tomorrow

Dr Michael Gale is a cytogeneticist at the Agricultural Research Council's Plant Breeding Institute, Cambridge

Where today can you find farm workers being dwarfed by the wheat crop, as Brueghel painted it in the 16th century? Traditionally, wheat has been a tall plant. But things are changing. The wheats grown in Britain in the early decades of this century stood about 130 cm tall, nearly 4½ ft. Today, cereals as tall as this are a great embarrassment. Straw is no longer necessary within the new intensive agriculture since the change from mixed farming, and its value for thatching is rapidly diminishing. More important, however, have been the greater yield potentials that came with the use of chemical fertilisers, for if tall plants are heavily fertilised, they simply collapse—or "lodge".

Breeders once thought this dilemma was insoluble—it seemed that plants with the genetic potential to yield heavily were inevitably tall. But in the years after the Second World War, British breeders rearranged the genes within the traditional varieties, producing types that yielded heavily but were only about 100 cm tall. Some of those early post war "standard" varieties, which were far less inclined to lodge than the earlier types, are still popular. Cappelle-Desprez is one example.

More dramatic decreases in the height of the wheat crop were heralded by the introduction of the extraordinarily short Japanese wheat known as Norin 10 by the American breeder Orville Vogel. Norin 10 itself was by no means an ideal variety for western agriculture. Its faults included a tendency to pollen sterility; unreliable seed emergence; and susceptibility to a host of diseases, especially those prevalent in western Europe such

as mildew, yellow rust, eyespot, and Septoria. From Norin 10, however, were bred the semi-dwarf varieties that swept the world during the "green revolution". These semi-dwarfs, bred for the tropics and sub-tropics, have not proved suitable for Britain. But, by introducing Norin 10 genes into the winter wheat breeding programme at the Plant Breeding Institute, Cambridge, Francis Lupton has produced the first semi-dwarf for use in northern Europe. The best of these varieties, known as Hobbit and Fundin, are already outyielding the best standard British variety by more than 10 per cent. They could be available to the farmer by 1975.

Clearly, high yielding wheat does not have to be tall. Clearly, too, the desired lack of stature can be produced in different ways. We can rearrange the genes of tall varieties that already have such desirable characteristics as high yield and reasonable disease resistance. Alternatively, specific dwarfing genes can be introduced from dwarf varieties such as Norin 10—or perhaps from other unrelated, dwarf varieties such as Minister Dwarf from Belgium, or Tom Thumb from Tibet.

If we are to devise rational breeding programmes, we need to know how the various combinations of dwarfing genes produce their effects. From the start it looked as though the plant hormone gibberellic acid (GA) was involved. Before even the first Norin 10 semi-dwarf, Gaines, rocked the American agricultural boat, Orville Vogel discovered that Norin 10 was insensitive to GA, which has the dramatic effect of transforming some dwarf peas and beans into tall plants. Yet other successful semi-dwarfs, in which height had been bred down from tall wheats rather than up from the dwarf habit, are as sensitive or more so than tall wheat varieties.

Unfortunately, wheat is a cumbersome plant for genetic analysis. Unlike cereals such as barley and maize, which are diploids, wheat is a hexaploid. It has 42 chromosomes, of which 14 derive from each of three different diploid ancestors. In each of the three sets of seven pairs of chromosomes, known as the A, B, and D genomes, pairs of chromosomes are found which control similar genetic functions. Thus the genetic complement may be classified into seven different groups, each containing chromosome pairs from each of the three genomes. In practice, many plant characters are controlled by the three chromosome pairs within a particular group—and genes present in triplicate seriously complicate conventional genetic analysis. Moreover, wheat is a highly selected inbreeding species in which interactions between different genes have been built up since man first started to farm the cereal. This means that often, particular genes may be detected only in the presence of one or more others.



Figure 1 The heights of the most promising new semi-dwarf variety compared with Cappelle and the dwarf parent Norin 10 Brevor 14

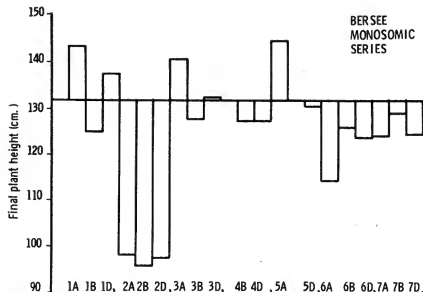


Figure 2 The effects of removal of individual chromosomes from the variety Bersee. The bars represent the heights of the 41-chromosome monosomics compared with the 42 chromosome euploid variety. Many chromosomes affect height but removal of the chromosomes 2A, 2B and 2D reduce height by 25 per cent

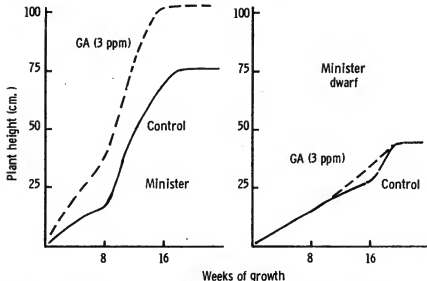


Figure 3 The effect of continuous GA application on the height of a tall and dwarf plant. The effect of GA on the dwarf is minimal compared with the tall variety

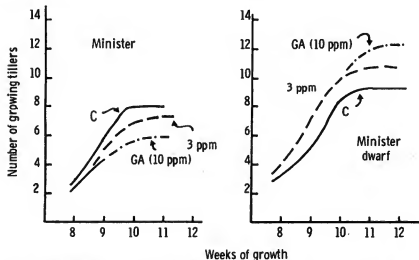


Figure 4 The effect of continuous GA application on tiller production in a tall and dwarf variety. GA has the opposite effect in the dwarfs

Finally, a quantitative character such as plant height is affected by several other traits—such as spring or winter habit, day-length requirement, and flowering time—all of which are under separate genetic control.

Nevertheless, where only a very few genes of major effect control a character, these may be analysed using Mendelian techniques. This is the case with Norin 10, in which dwarfism is controlled by only two or three genes interacting to produce the dwarf habit. It also applies to Tom Thumb and Minister Dwarf, in both of which dwarfism is controlled by a single potent gene. These genes represent different potential sources of dwarfism because any cross between the dwarfs produces tall plants in the segregating F_2 generation. Also, all three dwarf varieties are insensitive to GA.

Analysis of the number of factors controlling height in tall varieties where many genes are involved is more complicated. It is done by using a genetic tool available only in a polyploid. Whereas loss of a chromosome kills or severely disables diploid organisms (including most other cereals), wheats lacking one of the 42 chromosomes are still viable. Indeed, whole series of 41 chromosome "monosomic" wheats can be produced, each one missing a different chromosome. The way in which each monosomic differs from the euploid—the 42 chromosome plant—provides clues to the role of whatever chromosome is missing.

Height and chromosome removal

One such series, developed at the Plant Breeding Institute by Dr Colin Law in the standard variety Bersee (which is taller but of similar pedigree to Cappelle-Desprez), shows clearly that removal of almost any chromosome will affect height. But the three monosomics that lack one or other of the group 2 chromosomes are the most striking: they are 25 per cent shorter than the euploid Bersee. They are also reminiscent in other ways of semi-dwarfs based on Norin 10. They have a shorter coleoptile (the sheath that protects the shoot as it first emerges from the seed), broad stems and leaves, and a tendency to sterility. They differ from the major gene dwarfs, however, in that they respond markedly to GA.

In this difference lies the clue to two very different physiological routes by which the plant breeder might arrive at his short strawed plant. Gibberellic acid is present in most plants and it affects growth and development by influencing cell division and elongation. In studying the role of GA in the plant, as with most other hormone studies, conclusions are drawn from two sorts of experiments. In one type we monitor what happens when we feed a plant with the growth regulator. In the other, we observe changes in the plant's own endogenous hormones in either different environments or genotypes.

In the GA-sensitive monosomic semi-dwarfs, we find that application of CCC (chlorocholine chloride, a synthetic hormone that reduces plant height, apparently, by blocking the endogenous synthesis of GA) has less effect

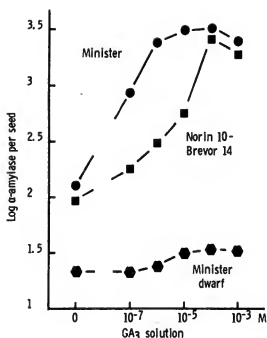


Figure 5 The relationship between GA and α -amylase production in the seed at germination. The Norin 10 based dwarf behaves similarly to a tall variety whereas the Minister Dwarf is insensitive to GA at this stage

than on the euploid. Evidently, removal of any of the group 2 chromosomes reduces the availability of GA in the plant, probably by removing some of the genes that controlled its synthesis. This is apparently the case, because plant extracts from the monosomics contain only half as much GA as extracts of the taller euploid.

The major gene dwarfs are unresponsive to both GA and CCC. The reason for this was discovered by Dr Margaret Radley, then working at Imperial College, London. She found that Norin 10 and several derivatives all had extremely high levels of free GA in growing tissues. This indicated that this type of dwarfism involves not a lack of GA, but, presumably, a block in its utilisation.

There is now evidence that the two Norin 10 dwarfing genes, and those in Tom Thumb and Minister Dwarf, are each associated with the inability of the plants carrying them to respond to GA. This results in the plants' endogenous levels being boosted from about two nanograms per gram to more than 10 nanograms.

On the other hand, in the monosomic semi-dwarfs the availability of GA to the plant is limited by regulation in its synthesis rather than utilisation. Apart from differences in total GA in the semi-dwarfs, the relative amounts of the various forms of the hormone also differ. In tall wheats GA₃ (the form known as gibberellic acid and usually used in dosing experiments) and GA₁ are found free in the cells and are thought to participate directly in regulating plant growth. Normally, GA₃ constitutes about 10 per cent of the total activity, but in the major gene dwarfs such as Norin 10 this proportion is raised to 40 per cent or more. The question the plant breeder now wants to answer is: "How will these differences affect plant per-

formance in ways other than height?"

Almost all aspects of growth and development in wheat, from germination to seed set, can be influenced by GA and are naturally regulated by the plant's own hormone, either alone or in combination with the other major hormones—the auxins, the cytokinins, and inhibitors such as abscisic acid. One such aspect of development that must be considered by the plant breeder is tiller production. A wheat plant has the potential to form many stems or tillers. In practice only a few are produced, and even fewer actually form the large ears that make up the main crop. While the farmer can adjust his sowing rate to give the required number of ears per unit area in his crop, he will want to minimise energy spent on producing shoots that do not form ears—these are known as back tillers.

Apical dominance increased

When applied to tall wheats, GA increases apical dominance, as it does in most higher plants. This in turn reduces lateral growth, so that fewer tillers are formed. However, the same dose of GA applied to dwarf wheats has exactly the opposite effect—more tillers are produced. Under field conditions in Britain, Minister Dwarf, Tom Thumb, and Norin 10 crosses all produce a lot of tillers—probably as an indirect response to their high endogenous GA levels. And recent observations of the British Norin 10 semi-dwarfs show that although they have higher final tiller numbers than their tall parents, they tend to form even more unproductive back tillers. Breeders are obviously going to find it difficult to separate shortness from high tiller production in varieties using GA-insensitive dwarfing genes. In semi-dwarfism due to a limited supply of GA, the tiller number will also be increased. In these cases, however, the result is much less marked.

The results discussed so far indicate that GA metabolism and action (or the lack of it) are similar in the three major gene dwarf types. But genetic evidence shows that the abnormal GA metabolism in these varieties is controlled by different genes. As with many characters in wheat, the difference may well be that similar genes are carried on different chromosomes within the same group and that the genes may not necessarily act in different ways. However, any differences in the biochemical mechanisms controlled by the genes are open to exploitation by the wheat breeder.

One such difference between the dwarfs can be seen in an important aspect of development that is controlled by GA. In the early stages of germination GA, produced by the embryo, directly stimulates a synthesis of hydrolytic and proteolytic enzymes which degrade the reserve carbohydrates and proteins in the seed, and make them available to the rapidly growing seedling. During wet British summers, grain sometimes begins to germinate in the ear before harvest. This "sprouting" causes the aleurone cells surrounding the grain to produce high levels of the enzyme α -amylase. Such grain, if used

to make bread, gives an unacceptable loaf with a sticky crumb structure and uneven cell size. In 1968, a bad year, Britain had to import an extra 8 per cent of grain for milling because of sprouting—adding £7 million to the national food bill. Clearly, then, the chain of events that begins with premature GA production in the embryo and ends with high levels of α -amylase in flour, is highly undesirable.

The GA response of the aleurone layers of the seeds of Norin 10 derivatives and of the Bersee group 2 monosomic is not very different from that of tall wheats. Either Norin 10's insensitivity to the hormone has not yet developed, or GA-insensitivity simply does not operate in the aleurone cells. However, the seeds of both Minister Dwarf and Tom Thumb show only a negligible response to GA in the aleurone layer. Initial α -amylase values are about 10 times lower than in tall varieties, and the response to added GA in the early stages of germination is very slight. Accordingly, the level of α -amylase in the flour made from Minister Dwarf or Tom Thumb grain is very low, and the GA-insensitivity confers an apparent resistance to sprouting—both very desirable attributes for a British wheat. Genetic evidence suggests that the aleurone response to GA is controlled by the height genes themselves. This demonstrates that the very fundamental way in which these genes act upon growth regulation to produce short stature in the mature plant is manifest even in the first 24 hours of the plant's growth.

In this case the site of GA synthesis (the embryo) and the site of action (the aleurone cells surrounding the endosperm) may be isolated from one another. Experiments in which embryos from responsive varieties are transplanted on to endosperms from insensitive varieties, and vice versa, show clearly that the degree of GA-sensitivity is a property of the endosperm itself. Indeed, an understanding of the nature of the block in GA utilisation will probably come from this type of tissue. The finding that GA insensitivity need not extend to all phases of development in all plant organs is an important one, because it opens up the prospect of breeding a plant in which unwanted attributes may be suppressed, and other traits such as yield and quality components exaggerated, by

allowing a response to the dwarfs' high endogenous hormone levels.

There are two ways in which Norin 10 does apparently respond to its own hormone—both with detrimental effects on yield. The flag leaves of this type of semi-dwarf have high sugar levels, as may be found in standard varieties after GA treatment. This may contribute to the disease susceptibility of these lines by providing a better environment for parasitic fungal diseases. And in parts of the world where overwintering resistance to cold is an important consideration, breeders have found that Norin 10 dwarfism is associated with poor cold tolerance. This is also probably linked with GA response, because cold tolerance is impaired in standard varieties by application of GA and is improved in the group 2 monosomic form of semi-dwarf. For both these characters, it may prove advantageous for the breeder to incorporate a more rigid insensitivity to GA or use a GA deficient form of dwarfism.

The application of knowledge already gained about the relationships of dwarfism to hormone regulation of development is not restricted in its application to bread wheat, *Triticum aestivum*. The same genes and their effects may also be exploited in the tetraploid macaroni wheats, *Triticum durum*; in hybrid wheats developed in the same way as the high yielding maize hybrids; and in the new man-made cereal, *Triticale*, made from hybrids between wheat and rye and which is beginning to show very promising results in both Mexican and British programmes.

Although only genes causing aberrant gibberellin metabolism have so far been discovered and investigated, there is no reason why genes affecting the synthesis or roles of other hormones might not be manufactured by mutation procedures. They may even be already available, but as yet undiscovered, in the world wheat collections. As with other types of genes which the plant breeder has sought out and exploited in his high yielding lines (such as those for disease resistance in wheat and for high lysine content in maize), the effects of genes regulating hormone activity can be well predicted. And because of their very basic nature they give rise to large changes in plant forms and may be a very important tool for the breeders of future super cereals.



Figure 6 (left) Wood engraving 1800. (right) Francis Lupton standing by his new variety, Hobbitt

The probable costs of reactor safety

Environmentalists and engineers in the United States are involved in a bitter argument over the safety of light water reactors. The anti-nuclear lobby is interpreting the facts and figures in such a way as to make hypothetical accidents an everyday occurrence

Simon Rippon

is editor of
Nuclear Engineering
International

The risk to the public of the United States from an accident at a nuclear power plant has been estimated at a fatality probability of about 10^{-10} per person per year. Clearly a probability of this order is very approximate and may be out by a factor of 10 or even 100 (in either direction). Some would say such a figure is meaningless: but it does allow us to establish from the outset that, when talking about the safety of nuclear power plants, we are dealing with levels of safety many orders of magnitude better than any other human activity and no less than 10 000 times safer than typical "acts of God". The selection of risks listed in the table should help further to put nuclear power plant safety into its proper perspective.

The death risk to US population from selected hazards

| Hazard | Probability of death per person per year |
|-------------------------------|------------------------------------------|
| Cancer (all types) | 1.6×10^{-5} |
| Auto accidents | 2.8×10^{-4} |
| Drowning | 3.7×10^{-5} |
| Choking on food | $\sim 10^{-5}$ |
| Cancer from medical X-rays | $< 1 \times 10^{-5}$ |
| Lightning | 0.8×10^{-6} |
| Cancer from nuclear effluents | $< 4 \times 10^{-6}$ |
| Nuclear power plant accidents | $\sim 10^{-10}$ |

One reason for special concern about nuclear power plant safety is the belief that the extent of a major accident would be far more widespread and devastating than anything we have known before. This fear is partially influenced by the devastation seen to have been caused by atomic bombs which is not strictly speaking relevant in the case of a controlled chain reaction. But it must be admitted that the inventory of radioactive material inside the fuel of an operating nuclear reactor suggest that nuclear power plant accidents might assume devastating proportions if substantial quantities were somehow to escape to the environment.

This introduces the idea of relating accident probability to potential seriousness of the consequences in order to arrive at a criterion for an acceptable level of safety. Again in an attempt to put nuclear accident probabilities into perspective with other risks of comparable or very much greater seriousness, it is worth quoting the probability of a jet airliner crashing on a packed football stadium—this has been estimated at a few chances in 10^5 ; or the probability of an exploding star delivering a lethal dose of cosmic radiation to the entire surface of the Earth which has been put at 2 in 10^5 .

Another reason for the disproportionate concern about nuclear power plant safety has arisen from the preoccupation of designers and licensing authorities around the world

with the so called "maximum credible accident". Defining an arbitrary cut off between credible/incredible is a perfectly legitimate technique for establishing limits in design and regulation of plants. But in the hand of interveners' lawyers at licensing hearings in the US these hypothetical accident scenarios have been transformed into everyday occurrences. The more balanced probability approach which can be used for detailed analysis of all possible accident trains is unfortunately not yet sufficiently developed to find acceptance with licensing authorities around the world but this could change in the not too distant future.

Probability analysis

An extensive study based on detailed probability analysis of operating nuclear power plants in the US, and drawing extensively on experience from the manned space programme, is currently being carried out by a team at MIT under the direction of Professor Norman Rasmussen with publication of a first report scheduled for early this year. Dr Herbert Kouts, director of the newly formed Division of Reactor Safety Research of the US Atomic Energy Commission, has stated that after completion of the Rasmussen report further development of the probabilistic analysis will become a staff function of the new division.

Some figures from the Rasmussen report were made known prematurely last week. The chance of a reactor core meltdown is estimated to be between 1 in 10^6 and 1 in 10^7 years, and the probability of such an accident affecting a large number of people is put at 1 in 10^6 to 1 in 10^{10} years. We must wait to see these figures in the overall context of the full report, but they do reinforce the belief that the risk to the public from reactor accidents is extremely small.

In the meantime the questions associated with "maximum credible accidents" of light water reactors have been brought to the attention of the public, and the nuclear industry must answer these questions to the satisfaction of the public. Before dealing with some specific issues, however, it is worth running through the three basic levels of the "defence in depth" safety philosophy adopted in the US for design and regulation of all nuclear installations, so that we can at least consider specific issues in their correct context.

The first level of safety involves detailed design of the plant for maximum safety in normal operation and maximum tolerance for system malfunction. It involves the use of design features inherently favourable to safe



The President's reactor —the Southern California Edison Company and San Diego Gas and Electric Company operate this 430 megawatt pressurised water reactor at San Onofre, near President Nixon's "Western White House" at San Clemente

operation; great emphasis on quality control at all stages of manufacture and construction; redundancy in safety related design features; and the establishment of test and inspection techniques prior to the acceptance of the plant which will be applicable throughout the plant lifetime. Features of light water reactor designs which are important at this level of safety include: the inherent stability of the nuclear chain reaction arising from a temperature coefficient which is more negative than any other reactor system (as the temperature rises the number of energy releasing reactions falls); the use of a large volume of water for primary cooling and moderation which provides good retention of radioactive materials if the high integrity of the fuel cladding is breached and fissionable material leaks out of the fuel "cans"; and the relative overall simplicity of the plants which greatly eases the problems of quality control and inspectability. Features of the light water reactor which are, relatively, less favourable than other reactor systems at the first level of safety include: a high power density in the reactor core which means that effective cooling must be maintained even for some time after shut down of the reactor; and the need for a very high pressure primary circuit to keep the water coolant in a liquid, or controlled boiling, state.

The second level of safety involves the assumption that incidents will occur in spite of the care taken at the first level. It calls for the provision of safety systems to protect the operators and the public, and to prevent or minimise damage when such incidents occur. Considerations at the second level include: a fast acting reactor shut down system activated by redundant and independent instrumentation channels; control features which limit the rate at which power can be increased either by normal control rod operation or accidental ejection of any element of the control system; emergency core cooling systems (note the plural of systems) designed to provide adequate core cooling in the event of a primary system depressurisation or loss of coolant accident; and guaranteed power supplies for all essential services around the plant. Due to the inherent features mentioned at the first level of safety, the requirements of the fast shut down system on light water

reactors are relatively less demanding than other systems (though still very important) and the provisions for maintaining the integrity of the primary pressure circuit and emergency core cooling are relatively more demanding (though not insurmountable).

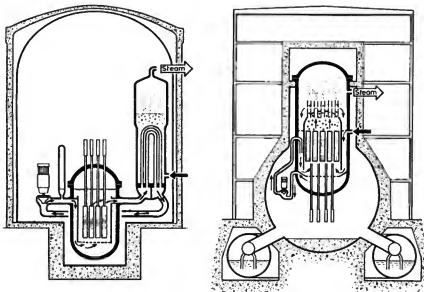
The third level of safety assumes that some of the protective systems provided at the second level might fail simultaneously with the malfunctions at the first level which they are designed to control. It calls for the provision of additional safety systems to contain within acceptable limits the extent of such multiple incidents and in particular to protect the public from the consequences of the accident. Bearing in mind the greater demands on pressure circuit integrity and the emergency core cooling systems for light water reactors, it is no surprise to find that third level protection against these second level systems assumes relatively greater importance. This leads to the huge double-walled containment buildings enveloping the entire primary plant of light water reactors and designed to contain the full potential release of energy from the reactor core. For comparison it is worth noting that third level pressure containment of this type is not considered to be necessary for gas-cooled reactors of British and French design.

The last resort

One of the problems in designing the third level safety system is the assessment of the margin of safety required to protect against multiple incidents which by definition are very unlikely and of which there is little or no experience. It is this problem which led to the development of the "maximum credible accident" concept as the basis for design of third level systems. Essentially this says that the situation can not be worse than the "maximum credible accident" and therefore if the third level safety systems are designed with sufficient margin to contain such extreme situations it is reasonable to assume that the overall margin for the whole plant is more than adequate.

It can not be stressed too strongly that the "maximum credible accident" concept was originally intended for assessment of ultimate back-up safety systems where uncertainty about the nature of accidents prevents the use of a more logical engineering design approach. It is stupid—in some instances even dangerous—to apply these hypothetical extremes to the lower levels of safety where perfectly good engineering practice allows a more realistic approach. But this is in effect what has happened in the long drawn out US controversy over the adequacy of emergency cooling systems.

The maximum credible accident adopted by the US regulatory bodies for the design of the containment building of a light water reactor is an instantaneous "guillotine" break of a primary coolant pipe at the most unfavourable point and displacement of the pipes in such a way that full flow can escape from both ends. This is a valid extreme situation to assume for the ultimate containment capacity required of the building around the



Light water reactors have uranium oxide fuel pellets in zirconium alloy tubes. In a pressurised water reactor (left) ordinary water circulates through the core to heat exchangers where steam is generated. In a boiling water reactor (right) steam from above the core goes straight to a turbogenerator. PWRs are built inside a double walled container equipped with an ice condenser or water sprays to condense escaping steam. BWR containers incorporate a large pool of water to condense steam

plant. But it is not a realistic basis for the optimum design of emergency cooling systems intended to limit the temperature rise in the reactor core for a broad spectrum of possible loss of coolant and depressurisation incidents. Even less is it a realistic basis for assessing design margins required for first level safety features such as fuel cladding integrity.

Without going into the lengthy history of the emergency core cooling controversy it is possible to say that new design criteria have now been published by the US Atomic Energy Commission and in spite of the almost ridiculous basis upon which these criteria are based, all new light water reactor designs should have no difficulty in complying. It will take a few months before the reactor manufacturers can assess in detail the implications of the new criteria on each of the plants currently operating or due to operate in the near future, but at worst they are only expected to involve deratings of the order of 5 to 10 per cent on some plants, pending the introduction of a new fuel design which can be phased in over a period of about three years.

Another issue of light water reactor safety which has assumed great importance in the UK as a result of comparison with gas cooled reactors in concrete pressure vessels, is the question of whether catastrophic failure of a massive steel pressure vessel—the giant “pot” that contains the reactor core—is on the credible or incredible side of an arbitrary line. Clearly licensing authorities in different countries must make up their own minds on such basic assumptions and plant designers must act accordingly.

If it is decided that a major rupture of the pressure vessel rather than a guillotine break or a primary pipe is to be considered as the

maximum credible accident in designing the containment building, then that building must be designed to sustain somewhat higher maximum pressure transients, and the concrete wall around the pressure vessel must be designed to stop any missiles ejected from the rupturing vessel. Just such a design exercise was carried out in response to German licensing requirements for a plant which was planned for location near to a large population centre.

But no self-respecting engineer should be satisfied with this brute force solution to an arbitrary judgement. A more satisfactory approach is a better understanding of possible failure mechanism (in particular brittle fracture—a failure mechanism which first came to light in warships operating in icebound waters) and appropriate specification of quality control and in-service inspection procedures to ensure that the conditions for such failures do not exist. Present knowledge of brittle fracture mechanisms and detailed analysis of a large steel pressure vessel, with particular attention to the highly stressed nozzle regions, suggests that a crack of at least 5 cm would have to exist before runaway fracture could develop.

It is therefore possible to substitute for consideration of whether a catastrophic pressure vessel failure is or is not possible, the consideration of whether it is possible for a 5 cm crack to slip through the quality control procedures during manufacture and subsequent routine inspections—allowing of course for the probability of human error in the inspection procedures on several consecutive inspections. With ultrasonic techniques capable of detecting cracks down to 1 or 2 mm this alternative acceptance criterion should not be too difficult to meet. Also just around the corner are promising acoustic emission techniques—with microphones able to detect the sounds a crack makes as it grows—which promise the possibility of continuous monitoring for the development of cracks again down to the millimetre size range.

Hypothetical accidents

In addition to the issues associated with design basis accidents the nuclear industry has also had to contend with a barrage of “what if” questions which bear no relation even to a hypothetical accident chain. It was in response to this sort of question, posed by insurance interests who wanted to know what was a reasonable upper limit of liability, that the US Atomic Energy Commission in 1957 carried out a study of the consequences that might result if by some unknown mechanism 50 per cent of the fission product inventory of a 500 MW(th) power reactor were to escape to the environment under the most adverse weather conditions (of a type that might prevail for 10 per cent of time).

The results of this study, which were published, estimated in the worst case, between 0 and 3400 fatalities, 0 to 43 000 injuries, and from 18 to 150 000 square miles of land that might be placed under some form of restriction due to radioactive contamination. In 1965 some consideration was given to updating

this study to reflect the increase in unit sizes or reactors being adopted (the present upper limit is 3800 MW(th)). But it was decided that the use of such extreme fission product release assumptions would give little additional insight into the probability that such releases will occur from plants currently in service. Failure to update this study was interpreted by US opponents of nuclear power as an attempt to conceal facts that were too horrifying to be made public.

There are, in fact, good technical grounds for saying that the 50 per cent fission product release assumption is just too incredible to be of any value. The fission products would have to escape from the ceramic fuel pellets, through zirconium alloy cladding, through a large volume of water, through the massive steel walls of the primary circuit, through the steel liner of the containment building and through the outer concrete shell of the containment, and at the end of this tortuous route they would have to be in a sufficiently volatile state to take advantage of the 1 in 10

adverse weather conditions.

Attempts have been made to postulate a mechanism by which this might happen and the least improbable is the so called "China syndrome". This assumes a complete loss of coolant in the reactor vessel; complete failure of all the emergency core cooling systems; a complete core melt down with the molten fuel collecting in an orderly way in the bottom of the vessel such that the full residual heat can be applied to the task of melting its way through the massive steel vessel, through the steel liner of the containment building, through many feet of reinforced concrete foundations and on through the bedrock in the general direction of China. But somewhere en route the fission products which have shown such remarkable cohesion in melting their way out, split up and become so volatile that 50 per cent of them can escape from the bedrock and take advantage of a spell of bad weather. Surely we have reached the realms of science fiction and it is time to conclude this article.

Behavioural toxicology

The effects of low doses of some chemicals, such as trichloroethylene, may be detectable only by observations of the behaviour of intact animals

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Back in the good old days when experts were experts regarded with proper respect, say 25 years ago, toxicology was mainly the science of the dose that would kill you and of what your liver looked like afterwards. After thalidomide this is unfortunately still important. But toxicologists now take a greater interest in a far more subtle problem. What is the lowest dose which just begins to do some damage?

Anything, no matter how vital to life, can be lethal at a high enough dose. You can drown in pure water. Conversely even botulinus toxin is safe if the dose is so low it is hardly there at all. The problem is where to draw the safety line with food preservatives or pesticide residues, where huge numbers of people could be exposed to tiny doses for many years. The issues are best illustrated in setting safe limits to the concentration of chemicals that people can be exposed to in the atmosphere at work.

About 25 years ago, ICI started to codify a "safe list" and this work has been greatly extended by semi-official organisations in America, the Soviet Union and elsewhere. Usually their recommendations for "threshold limit values" (TLV) are similar, but in a few cases they differ by a factor of 10 or more. The classic case is trichloroethylene (TCE), where the American and British recommendation is a limit, averaged over the working week, of 535 mg TCE per cubic metre of air (100 parts per million) and the Russian is 10 mg/m³ (2 ppm). The Germans, Japanese, Scandinavians, Swiss and Czechs, incidentally,

adopt intermediate levels between 40 and 75 ppm.

Trichloroethylene is a grease solvent, and TCE or related compounds are widely used in engineering or in dry cleaning. It is not inflammable, though it should not be overheated, nor does it pose any great hazard to the liver. However, as a solvent, TCE also penetrates the nervous system, and is an anaesthetic safe enough at 0.5 per cent for women in childbirth to administer to themselves. People operating a capstan lathe or a dry-cleaning machine ought not to be liable to anaesthetise themselves. Apart from the medical aspect, and the danger of accidents, productivity could fall dreadfully.

The question is, what is the highest concentration with no anaesthetic effect? One difference between the American and Soviet threshold limit values seems to be a value judgment. On the whole, the Russians take the view that any effect is potentially harmful, certainly if it is beyond the range of physiological adaptation without stress. The TLV is therefore admittedly an ideal, with no observable effect, but it is not certain how far behind the target the actual levels are allowed to lag. The Western view, on the whole, is that the TLV represents "conditions under which it is believed that nearly all workers may be exposed repeatedly day after day without adverse effect" (my emphasis). It is therefore not a sharp boundary, and allows for the possibility of genuine but trivial effects, or even of beneficial ones. Actual concentrations fluctuate from time to time, probably quite widely, so that the Western TLV represents, as it were, a safety-net. (This too, in practice, may be over-realistic.)

What about the workers? A survey by G. F. Smith of the Department of the Environment showed probably typical findings. About two-thirds of the workers exposed to TCE complained of a mixed bag of symptoms. Mainly they felt drowsy or fatigued; a few

had headaches were dizzy, or intolerant to alcohol or tobacco. You can always find grumbles if you ask, of course, but there were more complaints per head from more people among those more heavily exposed. Several authors have the impression that there is a threshold for subjective complaints, somewhere around the threshold where you can just detect the sweet smell of TCE, about 50 ppm.

These symptoms seem to be nuisances more than signs of actual danger and, if you are hard-hearted, hard-headed, or hard-up, you point to the fact that the financial cost of reducing air concentrations is inversely related to the health benefit. Reducing a high concentration to a moderate one is technically easy and saves lives. Reducing a moderate concentration to a low one is expensive and saves what? After all, drowsiness is not uncommon in the pure air of a summer afternoon. So you try to ignore complaints, or call for animal experiments to back them up.

The classical toxicologist is in a quandary here. TCE does not cause fatty liver at any ordinary dose, nor technicoloured spots. Rats breathing 100 ppm five days a week for 12 weeks do not sleep any longer after an anaesthetic dose of pentobarbitone. A toxicologist does not know how to ask a rat if it is feeling sleepy or has a headache, nor would he understand the rat's answer if he got it. The Russians have used conditioned reflexes. Can animal behaviour provide objective evidence of the effects of low concentrations of TCE?

"Now you see it, now you don't"

The trouble with animal behaviour as a test system, many people feel, is that "now you see it, now you don't". To measure it reliably you have to persuade or compel the animals to perform some objective action which you and other people can observe and count, at a time not of the animals' convenience but of yours. A method popular some years ago was the "pole-climbing" conditioned avoidance test. A rat is put into a box where a buzzer sounds every so often, for 15 seconds alone and 15 seconds added to electric shock through the grid floor. If the rat climbs the wooden pole provided, it is insulated from the shock. M. E. Goldberg and his colleagues from Pittsburgh showed that only the first four-hour exposure to TCE at 4380 ppm made the rat too limp to climb at all. However, two or three rats from groups exposed for several days to 200-4380 ppm failed to respond to the buzzer alone, as they had done previously. Avoidance of the shock was inhibited, while escape after the shock began was unaffected.

Etienne Grandjean of Zurich trained three rats to climb a pole in response to a light and the sound of a small lump of sugar dropping into a tray at the top of the pole. He found that after five or seven three-hour exposures to 800 or 200 ppm TCE, the rats obtained their sugar just as well as usual. Milan Horvath and J. Pormanek of Prague, and N. V. Bannova of Moscow have used Kotliarevsky's method, which is standard in the Soviet

Union. A hungry rat has to jump down from a platform and run across its cage to get food if a light shines or a high-pitched tone sounds, while running to a quiet buzz is a waste of effort. Horvath found that 75 ppm TCE, six days a week for seven weeks accelerated the response. Bannova must have had some very delicate techniques (or rats), for after only two weeks of a six months' test at 9 ppm, TCE began to retard her rats' response. Nevertheless, all three experiments agreed on something that the conditioned avoidance test does not measure. TCE acted to disinhibit the response: rats were more likely to respond, fruitlessly, to the wrong stimulus, or without any signal at all. Karl Battig and Grandjean found that rats were slower to swim a four-metre channel after six weeks at 400 ppm, if they carried an extra load, and after 13 weeks if not. Yet, after 43 weeks, they explored deep into a complex maze sooner and more often than rats breathing clean air.

Trichloroethylene therefore can change rats' behaviour and the concentration seems to make surprisingly little difference. It is tempting to try to classify the results. Slower swimming under load or slower pole-climbing suggests that TCE reduces the maximum physical effort that rats are able, or willing, to exert. Paradoxically, TCE also reduces inhibitions against exploring an unfamiliar maze or responding without the correct signal to go. Possibly it reduces the rat's equivalent of anxiety. These interpretations are tentative, of course, and result partly from some experiments that Helen Williams and I have made. We used groups of 16 male rats, housed in pairs, but exposed singly to TCE for six to seven hours daily, five days a week. We used concentrations of 100 to 1000 ppm for four to five weeks, with one group at 100 ppm for three months. We used two methods where the animals' behaviour is spontaneous; at least, we had not conditioned it deliberately. This let us observe more than one kind of behaviour at a time and distinguish a selective change in one kind from a generalised effect on all.

One method we have called "exploration-thirst". A rat was placed in an unfamiliar plastic cage similar to its home cage, and one of us counted the number of times it stopped walking around the cage to examine a distinct place on the floor, walls or roof. Exploration implies, however, not only motor activity but also information-seeking. We had therefore deprived the rats of water overnight and measured the time they took to find a water bottle in the strange cage and start to drink.

After five minutes, rats were returned to the exposure chamber. When they were tested again 24 hours later, they knew where to find water and started to drink sooner; nevertheless, they still had to explore the cage first. Rats were tested after 2½ or 5 weeks' exposure to TCE; at all concentrations they walked about the cage neither quicker nor slower than matched controls. Yet, particularly on the second trial, they started to drink significantly sooner. In this, TCE resembles sedative drugs like pentobarbitone, where small doses

Figure 1 In the first "baseline" observation there was virtually no difference in any kind of behaviour between rats that had been breathing clean air in the exposure chamber and controls. Following 1, 3... 24 days of exposure to TCE, rats showed slightly less of all kinds of behaviour, significant (marked *) only in exploration and in submission or escape

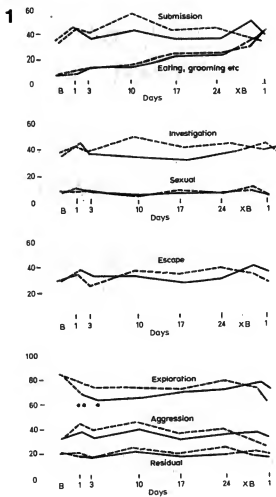
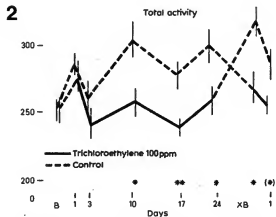


Figure 2 When all kinds of activity were added together, the fall was significant after 10 days. There was a "rebound" rise in activity after exposure stopped, with former controls showing a slight fall when exposed to TCE for one day (exposure chambers themselves have only a transient effect)



regularly have a paradoxical stimulant effect. However, whereas both compounds let rats drink sooner, TCE never had the motor stimulant effect of the drug.

If you separate paired rats, as for exposure to TCE, and return them to the home cage soon after "nightfall" in a 12-hour light/dim cycle, they come to show what looks like most of their daily social behaviour in the first five minutes. Not only do they explore the cage intensively, they investigate each other. Before they calm down to eat and drink, they fight excitedly—not to damage each other (bites are rare and never penetrate the skin), but to settle who's boss for tonight. The movements they make to threaten, or to signal submission, or to run away and escape, are

very conspicuous, easy to observe and count.

Standard drugs have specific effects on this system. Barbiturates often reduce submission and escape from a stranger, thereby disinhibiting aggressive or other approaches, without altering exploration, eating, or grooming. Chlorpromazine has broadly opposite effects. A "smoking dose" of nicotine selectively diminishes aggression towards the cage-mate without altering other behaviour or the total activity. So, when we looked at TCE, I was surprised to find just what the layman would expect of small doses of an anaesthetic: pairs of rats exposed to TCE showed less activity of all kinds than controls, with no one kind of behaviour reduced much more than any other. Figures 1 and 2 illustrate one of the experiments at 100 ppm.

Individual differences

There is an interesting interaction between dose, duration, and differences between groups of rats. One day's exposure to 1000 ppm was sufficient to reduce activity significantly. At 100 ppm one group of ex-controls very familiar with the procedure showed a fall in activity after one day; another group showed it after 10 days; and a third only after two months. Even in an inbred strain of rats there seemed to be individual differences in drug response, and it would be interesting to know why.

In a situation where rats are normally very active (averaging 60 actions a minute) TCE reduced activity by anything up to 30 per cent. In a situation where a response was inhibited by unfamiliarity and hence perhaps by anxiety, TCE accelerated it. Can we extrapolate to man?

Humans are usually assumed to be more, not less sensitive to drugs than rats are, so that if rats show an effect of TCE at 100 ppm (or even 9 ppm?), we must expect something in man. We can only speculate about what kind of effect—but a decline in the maximum rate of activity in rats is what you would expect if they were suffering the drowsiness, fatigue, or headaches complained of by people. A weakening in inhibitory control by the "higher centre" is what you would expect from a trace of anaesthetic as well as from alcohol. So I would guess that on a self-paced task, people exposed to the TLV concentration of 100 ppm trichloroethylene would perform at less than their maximum rate; under pressure, this might lead instead to increased errors. In an unfamiliar situation, an emergency perhaps, exposed people would be apt to act first and think later. This might well be beneficial, of course, but a lack of proper caution would not be without risk.

TCE has been investigated so thoroughly, largely because in most respects it is so safe. Some solvents are probably stronger anaesthetics, and others certainly damage the liver. The behavioural effect of TCE is an example where epidemiological surveys in man are consistent with experiments in animals, a fortunate situation not always obtained in any kind of toxicology. It is also a case where the eye is mightier than the microscope.

Black gold rush in the west

With considerable oil exploratory activity now planned in the Celtic Sea, Cornwall could soon find itself facing both the opportunities and dangers of a major oil boom

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A major task of the old Ministry of Fuel and Power, that has been resurrected with a new name and a Lord to guide it, is to accelerate the exploration and exploitation of Britain's own sources of primary energy. With the world as it is today, this means oil, and with developments in the North Sea well under way, all eyes are now turning to the Celtic Sea, the Western Approaches and the English Channel.

Suddenly, names begin to acquire a new significance. A year or two ago, the Celtic Sea did not exist. Today it is that part of what used to be the Irish Sea that is not Irish: the area from the North Cornwall peninsula, across the mouth of the Bristol Channel and along the Welsh coast. Just how much of the English Channel is Channel and how much is La Manche is still to be decided. Negotiations between Britain and France have been going on for 18 months in an attempt to draw a median line through the world's busiest shipping lane and until agreement is reached licences for oil and gas exploration will not be granted for the sea areas involved. It is likely that there are oilfields and there is talk of a major well just off the Isle of Wight. Whether or not anyone dares to erect a rig where it will offer an almost irresistible collision target may become a measure of the seriousness with which the oil crisis is viewed in Millbank.

Exploration licences have been granted for 43 blocks in the Celtic Sea and oil and gas found there will almost certainly be shipped or piped ashore to Pembroke Dock and Milford Haven, where adequate facilities exist. Oil found in the English Channel is likely to be taken direct to refineries in Hampshire or Dorset.

The concentration on Wales has led local authorities in Devon and Cornwall to adopt a fatalistic attitude toward the possibility of an oil boom in their own area. Cornwall feels it has already lost out to the Welsh and that in any case it can have little control over what may happen. If it opposes planning applications for on-shore developments, it would find itself overruled in Whitehall "in the national interest". Probably any boom will not affect the region unduly and if it does the council will be powerless to control it. The air of apathy is not helped by the present hiatus in the reorganisation of local government.

They could be wrong on both counts. It is true that one test drilling has been made already, only 55 miles from St Ives, and that neither the local authority nor the County Council were consulted, but no shore development was involved. In fact the well was dry. Yet something like £10 or £20 million has been invested in West British oil, there has been a positive strike in Dorset, and Cornwall is rife with rumours of oilmen prospecting harbours and shorelines and of at least

one farmer being offered a large cash sum for his land.

A glance at the map shows that of the blocks already licenced, several might be serviced better from Cornwall than from South Wales and once exploration begins in the Western Approaches, Cornwall is almost certain to find itself involved.

Involved in what? Oil has proved a very mixed blessing in North East Scotland and the Shetlands. Aberdeen has been assured that it is about to become the richest city in Europe, but for most people living there the only evidence so far is a doubling or trebling of house prices as part of the local inflation induced by the oil industry. In Cromarty and the Shetlands, the influx of highly paid workers has created social problems. They must be housed, new schools must be opened, hospital facilities improved and unless ways are provided to permit men, many of whom are separated from their families, to "let off steam", there is an increase in drunkenness and violence. Some local firms have done well, but most of the engineering work is done elsewhere and the hardware is imported. It is said that one company operating at Nigg Bay imports everything it uses from Texas, right down to its electric light bulbs: British bulbs do not fit American sockets. Jobs have been created. The Lord Provost of Aberdeen has said that 1400 new jobs were created by the oil industry in the city. A group of Cornish conservationists who went to Scotland to see for themselves what had happened reported 5000 new jobs created in a period of 18 months, but most of them were filled by newcomers and between 1971 and 1972 unemployment increased from 1.2 to 2 per cent.

Shetland's solution

In order to control development within its tiny land area, Shetland is trying to purchase compulsorily 14 000 acres and set itself up as landlord to the oilmen. This option is not open to the Cornish. The 14 000 acres in Shetland was owned by only seven people. A similar area of Cornwall might have 10 000 owners and compulsory purchase would be impossibly slow and complicated.

So what might Cornwall expect were there to be a full-scale oil rush? It is classed as a development area and the official figure for unemployment is high but many firms attracted to the Duchy by DTI grants have found it very difficult to recruit local labour: in fact there is a labour shortage in many trades. The employment figures are distorted by the large number of people who retire early, settle in Cornwall and register as unemployed, and by the seasonal workers who earn enough from tourism during the summer to see them through the winter, but who also register as unemployed. Neither group is

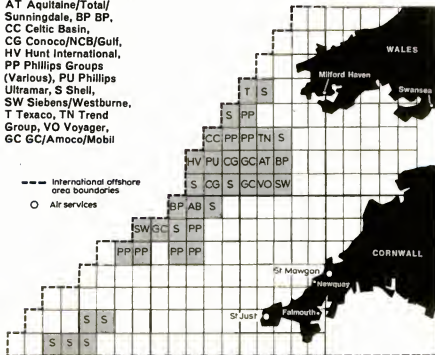
available for employment. Such workers as were recruited by the oil companies would be drawn from local firms. There would be a general wage rise in the trades affected which could combine with the labour shortage not in bringing wage rates up to those paid elsewhere in southern England, but in forcing local firms into liquidation. This would throw on to the labour market those other workers who could find no place in the oil industry.

Improvements in social services would have to be paid for by local authorities and so rates would rise. Property prices, already higher than those in Scotland, would rise still further. Such local inflation would harm all those not benefiting from the spin-off from oil. There would be such spin-off, of course. Hotels, restaurants and guest houses which normally close at the end of the tourist season might be able to remain open all year round. Local shipping agents, chandlers and anyone with transport or storage facilities to offer could do well. This has begun to happen already, even though the two ships currently working out of Falmouth are not manned by British crews.

Everyone seems paralysed by the size and speed with which the oil industry makes and satisfies its demands. One way or another local governments and conservationists must come to terms with it, because it is unavoidable. The capital investment represented by an oil rig is so high that it must operate at maximum capacity. The companies have no choice, but the larger of them wish sincerely for better relations with local people. A senior Shell official told me that his company found the stand taken by the Shetlanders refreshing and stimulating. He wished others would do the same so that local communities could be kept better informed and disruption minimised.

Concession areas,
showing licences already
granted:

AB Arpet & British Sun,
AT Aquitaine/Total/
Sunningdale, BP BP,
CC Celtic Basin,
CG Conoco/NCB/Gulf,
HV Hunt International,
PP Phillips Groups
(Various), PU Phillips
Ultramar, S Shell,
SW Siebens/Westburne,
T Texaco, TN Trend
Group, VO Voyager,
GC GC/Amoco/Mobil



The dangers come, however, not from the large companies, but from the small ones and the secondary and tertiary levels of the industry. It is they and their workers who are the cowboys of the 20th century, with the world as their range. Rig workers are not members of trades unions: they are simply out to get as rich as they can as fast as they can and they will accept harsh working and living conditions. They are tough and rough, and they follow the rigs wherever they go. When local workers join them, often they stay in this itinerant labour force.

Pollution is inevitable

Yet having made every allowance for the economic pressures operating within the industry, the added pressure of the energy crisis may force the technology of offshore drilling beyond its limits. A £600 000 oceanographic and weather study has been launched by the oil companies. The "Tikker", sailing out of Milford Haven, is examining the Celtic Sea to provide information about a seabed 350 feet down and weather that can produce wind gusts of up to 115 mile/h and waves 80 feet high. These conditions are comparable to those found in the northern North Sea. So far no one is looking at the Western Approaches. They are in the Atlantic itself. Pollution is inevitable. There are bound to be spillages, seepage and even the failure of the mechanism that seals a well in the event of a blowout is far from impossible. The oil released will be carried toward the Scillies and the tourist beaches of west Cornwall. Tourism will be affected and so will local fishing. At the moment the fishermen are enjoying a little hard-earned prosperity in a sea teeming with mackerel.

Perhaps the saddest aspect of the whole business is that the people of Cornwall, a little isolated from those living "up country", and enjoying a way of life not based entirely on materialism, will be drawn into the growth-oriented lifestyle of the industrial regions of Britain by exposure to the most materialistic work force in the world, just as the industrial nations are beginning to realise that it is no longer possible to sustain endless economic growth based on an ever-increasing consumption of energy. The Cornish people could face a bitter disappointment when the boom ended. It might be in 10 years, when the labour-intensive exploration and construction phase ends, with the first oil ashore by 1980, or in 30 or 40 years when the fields are exhausted.

The problems are not new. Central governments are notorious for their disregard for the welfare of the regions when it is necessary to exploit them in the national interest. It is high time that the west country woke up to the dangers and the opportunities they may be facing. Cornwall, Devon, and Dorset should join forces to provide a political force strong enough to ensure not that development does not take place, not that the oil and gas is not found and extracted, but that the exploitation is of the fossil fuel resources, rather than of the people who must live alongside them.

Technology review

Nuclear submarines to lay oil and gas pipelines

A proposal that nuclear powered submarines could be used to lay pipelines to offshore oil and gas fields is under consideration by the Department of Trade and Industry. The scheme, emanating from Vickers Shipbuilding and Vickers Oceanic, is one response to the government's increasing emphasis on undersea technology.

So far, every gas and oil line in the North Sea has been laid by the US company Brown and Root. Conventionally, pipelines are laid from a barge. A pontoon extending from the stern of the barge, and controlled by ballasting, supports the pipe from the barge almost to the sea bottom.

The difficulties of operating this kind of laying system in the notorious North Sea weather are great, as BP found to its cost when laying the first buried pipeline from the West Sole field. Brown and Root, in conjunction with J. Ray McDermott and SEDCO, is developing a £20 million semi-submersible barge for this very reason.

Vickers hopes to steal a march by cashing in on its expertise in two areas. It has carried out extensive inspection of

pipelines and telephone cables from the Pisces two-man submarine. And it has proved its capability in nuclear engineering by supplying engines for Royal Naval nuclear submarines for some 13 years.

The £30 million scheme is to develop a rugged reactor of roughly the same size and type as those used in naval submarines, delivering 10 000 horse power. The reactor could be used in two ways, according to Vickers. It could power a large submarine that would house men for as long as three months, or it could drive a train of smaller vehicles that would pull into position and join together pipeline sections as the vehicles crawl along the seabed.

Vickers has chosen an area ripe for innovation. The 1972 IMEG report on opportunities in offshore oil and gas said: "In view of the substantial long term demand . . . we believe that this [pipe-laying] is an activity meriting special attention". And although the report in general advocated "modern but 'conventional' equipment", it was "inclined to a different view" in the case of pipe-laying and burying. The report said: "the government financial backing

required would be considerable."

The government, so far, has been asked for a £50 000 to £100 000 pump-priming grant. The next step would be government assistance in projects for pipeline burying (£2 million) and laying (£24.6 million). Given the government's keenness to develop underwater technology and its acceptance of the IMEG report as the basis of a long-term strategy, Vickers' chances of winning support must be high. The only possible doubt is timing. Vickers says that its nuclear systems will need five or six years' development work, by which time most contracts for pipelines to already discovered fields will have been placed. Thus Vickers is, to a certain extent, gambling on future discoveries.

Fracas in French computer business

A French court last week refused to arbitrate when the Compagnie Générale d'Electricité (CGE) asked it to order the appointment of a new administrator for Fininfor. All this may sound a little esoteric, but underneath the CGE conflict with Thomson lies the future of the French computer industry.

Fininfor is a holding company in which Thomson holds 52 per cent and CGE 48 per cent. Fininfor in turn holds 61 per cent of the shares in the Compagnie Internationale pour l'Informatique (CII), the mainstay of French computers. The marriage between Thomson and CGE was "encouraged" by the French government in its determination to stand up to the United States. Thomson was to concentrate on telecommunications and CGE on nuclear generation, while both would give full financial support to CII.

But this dream of planned integration is now in tatters. The two giants parted company when CGE, not content with its nuclear role (Electricité de France had accepted its system and placed huge contracts), wanted to break into the telecommunications market with CIT-Transac. CGE also thought that Thomson had far too much say as the majority shareholder in Fininfor and thereby the virtual controller of CII, which with Philips and Siemens had set up Unidata destined to play David to the IBM Goliath.

Thus CGE asked the courts to name an independent administrator. Now this has been refused, the war between the two giants continues. In its manoeuvring against the US computer industry, CII is spending a lot of money. The first Unidata computer should be ready by 1975 and the gargantuan appetite for cash will have to be met. Thomson, Philips, and Siemens are all ready to go, but CGE is digging in its toes.

Research contractors: auxiliaries not partners

Although private industry in Britain spends £80 million per year on research and development outside its own laboratories, the value of "out-house" R & D is still generally thought to be minor. A report out this week (How to Market Contract Research, published by Interplan of Croydon) estimates that about £45 million is spent with the specialist contract research organisations. Major government laboratories, such as Harwell and Warren Spring, take 35 per cent of the money available, private contract research companies 30 per cent and the Research Associations 25 per cent. The report, which does not include the impact and scale of R & D contracts let by government departments, has tried to find out how industry actually regards and uses external research organisations.

It is a sobering report. Based on 64 in-depth interviews with industrial decisionmakers in the UK, it suggests that research managers in private companies do not automatically turn to contract research organisations when in need of technological solutions.

"Contract research has a disappointing image in the eyes of the decisionmakers in industry," says the Interplan study. "Typically it is felt that its contribution is useful and convenient, but its value is minor, and the service dispensable." The study

also suggests that contract researchers seeking to increase their share of the cake should set out to market themselves properly. They are advised to offer a "functional service" to industry and expose their project managers with adequate back-up publicity.

All but 14 of the firms sampled (chosen to provide a typical cross-section of likely contract research buyers) were members of at least one Research Association. However, the majority of the firms regarded their RAs "merely as convenient sources of up-to-date information, and felt that the programmes of research had little relevance to their needs."

Some 40 of the 64 firms surveyed had used independent and/or government contracts research establishments. The most surprising finding was that the majority of the informants attached little value to the services of the contractor—tending to regard him instead merely as a supplier of services and skills that either did not exist in-house or useful when firms' own facilities were overloaded. The report suggests: "The research contractor seems to be a minor auxiliary, not a partner in industrial research and development." In all the cases reported, the value of the work sub-contracted represented only a minute part of the company's research and development budget—typically of the order of 1 per cent.

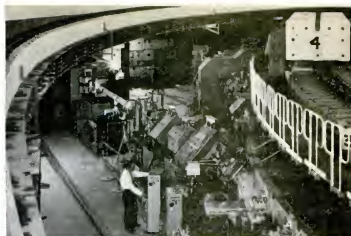
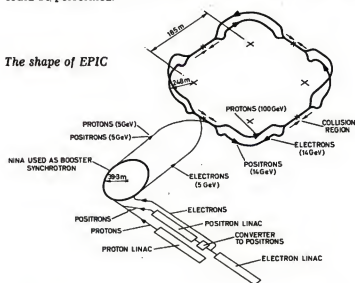
Will Nina and Nimrod get together?

A new plan for British high energy physics, involving the construction of an accelerator complex for electron-proton interaction, has been proposed by nine working parties of British physicists. The scheme would mean physically transferring Nina (an electron accelerator) from Daresbury in Cheshire to the Rutherford Laboratory in Abingdon, so as to form a new machine—EPIC (electron proton interaction complex).

EPIC would be unique, and because of this, British physicists are hopeful that other European nations would be prepared to contribute part of the cost of the second phase of the project, in exchange for the right to make use of the facilities.

If given the go-ahead in October 1974, the first step would be to transport Nina's accelerator to the Rutherford. Then a bigger and more powerful accelerator ring, 680 metres in diameter, would be added (actually the ring would be a square with rounded corners). Nina's equipment can accelerate electrons to 3 GeV, and the new ring would bring them to 14 GeV. This, the first stage, would cost about £20 million of British money, and would be complete by the early 1980s. Initially, experiments involving electron-positron collisions could be performed.

The shape of EPIC



Nimrod today: two beam lines can be seen leaving the synchrotron and entering the experimental hall at the rear

In the second stage another ring would be built above the first, in the same tunnel. Protons from the linear accelerator that forms the first stage of Nimrod would be injected into the second ring. (The remainder of the Nimrod accelerator would be closed down.) Conventional magnets would accelerate protons to 80 GeV; superconducting magnets could achieve 200 GeV. Protons would of course circulate in the opposite direction to the electrons next door, and at appropriate moments bending magnets would be brought into play to engineer collisions in the straight sections of the rings.

Because existing accelerators, Nimrod's experimental hall, beam transport facilities, and all the infrastructure of the two large pre-existing laboratories would form parts of EPIC, the cost of the second stage would, it is hoped, be kept down to about £15 million.

Cost sharing, plus this ingenious use of existing equipment at the Rutherford would, according to the physicists who have drawn up the scheme, mean no increases in the present annual budget for high energy physics in Britain. Because of this thrift, and the revitalisation of British research in this area that could result, the Science Research Council is understood to look favourably upon the idea. Money, however, may be harder to obtain. High energy physics with its expensive equipment and lack of immediate relevance is an obvious target for an economy-minded government.

Soviet cosmonauts have little control over Soyuz

The Soyuz spacecraft is little more than a "manrated unmanned satellite in which cosmonauts have minimal command, control and trouble shooting capability" claims the influential US magazine *Aviation Week and Space Technology* (21 January, p 38). It is clear from the report that US experts are taking advantage of the present US-Soviet cooperation for the 1975 joint flight to analyse carefully some Soviet space hardware. And one conclusion they seem to have reached is that "In some areas Soyuz capability is below that available in the Mercury spacecraft flown by American astronauts almost 13 years ago".

According to the article, the Soyuz craft, unlike Apollo, has no onboard computer, and so practically all operations are controlled by two pre-programmed drum-type sequencers. The command even the most complex manoeuvres such as flying the entire re-entry, and quite simple operation, such as switching on the cooling fans. The cosmonauts cannot generally introduce any new commands but can only initiate

those already contained in the programme. Ground control can, however, update commands by altering the timing of events.

The cosmonauts are able to manoeuvre the craft once in orbit. They have only two rates of attitude change, but can accelerate the craft in either direction along any of three axes. The *Aviation Week* article claims that the reason for the overwhelming degree of automatic control of Soyuz flight activities is that Man was not built into the Soyuz "control loop" from the start, as he was in the US.

For primary guidance and orientation, the Soyuz uses ion, horizon, infrared and sun sensors, but has no advanced computer to manipulate data from these sensors.

Using ion sensors to detect the direction in which a stream of ionised particles is flowing so as to determine the craft's attitude is a method used on board many unmanned spacecraft.

The Soyuz's periscope which extends from the descent module, can be used by the cosmonauts for primary attitude reference. During the day they can determine attitude by viewing the various

Earth/sky/horizon ratios on the viewing screens. At night the instrument is pointed away from the Earth, and is useless.

Direct comparisons between Soyuz and Apollo hardware in the *Aviation Week* article give the impression that the Soyuz is little more than a souped-up unmanned Earth satellite. It is well known that the Soviets lag some way behind the Americans in computer technology. When the Soyuz was being developed in the 1960s, they possessed no onboard computers. But it is doubtful that computers would have been installed on Soyuz, even if they had been available.

The Apollo was built for lunar landings, so onboard computers and a certain degree of manned control were vital. The Soyuz, on the other hand, is a purely orbital vehicle which does not need such sophisticated equipment.

Soviet space philosophy, a reflection of the economy perhaps, has always leant towards simplicity and standardisation. Absolute ground control is in line with these ideals, on the assumption that people on the ground are in a better position to control, than cosmonauts in a strange space environment.

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Ontario Hydro's Pickering Generating Station

... CANDU (like Britain's prototype Steam Generating Heavy Water Reactor at Winfrith) uses the pressure-tube concept.

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... CANDU does not require enriched uranium. Both North American reactor types depend on isotope separation. But CANDU's competitor uses ordinary water and enriched uranium, while CANDU uses heavy water and natural uranium. Enriched uranium is made by separating the Uranium-235 isotope from the Uranium-238 isotope; complex, expensive plants using secret processes are needed. Heavy water is made by separating the heavy

hydrogen isotope in water from the ordinary hydrogen isotope; these plants are quicker and cheaper to build and the technology is known.

... CANDU uses fuel that's cheaper to buy and much more readily available, and CANDU gets more out of it. Because natural uranium is available from many countries, no one has a supply monopoly and future prices should remain relatively stable. Production costs for enriched uranium, however, are increasing rapidly. So CANDU's fuel cost advantage can only improve with time.

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beginning the Canadian nuclear power programme has been featured by close co-operation between Atomic Energy of Canada Limited, a federal Government agency, and the large Canadian electric utilities. Ontario Hydro has had more than a decade of operating experience with the first CANDU prototype and nearly three years with Pickering's first 500,000 KW unit, and has many more CANDUS under construction and planned. Hydro-Quebec is also operating and building CANDUS and CANDUS are in the future plans of other Canadian utilities.

Atomic Energy of Canada Limited traces its nuclear research and development back to partnership with Britain at the start of the nuclear age three decades ago. Is this not a good time for the partnership to be renewed?

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Weather forecasts can solve strikes

Predictions of bird migration patterns based on local weather forecasts have proved an effective means of reducing bird strikes at a Canadian forces air base at Cold Lake in Alberta, according to a paper by Hans Blokpoel from the Canadian Wildlife Service (Information Canada cat. no CW69-1/16).

Single-engined fighter planes at low altitude are particularly susceptible to the ingestion of birds: fatal accidents from bird strikes are not infrequent. Birds can sometimes be permanently scared away from airfields, and radar can be used to avoid large flocks of migrants. But small birds migrating in loose flocks produce diffuse radar echoes which cannot easily be avoided by hedge-hopping aircraft. The only way to prevent bird strikes during low-level exercises is to suspend such flying in times of intense small-bird migrations, which occur mainly at night.

Studies of the relationship between local weather and migration density at Cold Lake suggested that four factors influenced bird movements. Blokpoel

defines these factors as either favourable, unfavourable or neutral to migration.

At surface level in spring, when migration is mainly NW, calm conditions or SE wind up to 5 km/h were favourable; NW winds were unfavourable and SW or NE were neutral. Wind at 900m and at 1500m were considered as two separate factors, but they turned out to have the same effects as ground level winds from the same directions. Lack of rain or other precipitation was favourable, scattered showers were neutral, and extensive falls were unfavourable.

Blokpoel found that when all four weather factors (precipitation plus wind at ground, 900 and 1500m) are neutral, migration will be of average density. If most factors are favourable, migration will be above average, with maximum densities when all four are favourable. Extensive and prolonged rain will suppress migration completely, even if all wind factors are favourable. However, if most factors have been unfavourable for three consecutive nights, migration will start even under inhibiting conditions. In autumn, when migration is mainly to the SE, the opposite wind conditions apply.

In the spring and autumn of 1970, Blokpoel used local weather forecasts to predict migration density at Cold Lake on a scale from zero to eight; actual migration was measured by radar. In spring, the weather forecasts themselves proved inaccurate on 2 out of 35 nights, and in autumn on 6 out of 60. For the remaining nights, migration prediction was remarkably good.

In spring, predicted migration densities over a whole night were 96 per cent accurate, with high densities (five or over on the scale) predicted with an accuracy of 98 per cent. In the autumn the results were weaker, with an overall accuracy of 81 per cent and with high-density migration correctly predicted 92 per cent of the time.

A precise assessment of the usefulness of the Cold Lake Base experiments is not possible for reasons of military security. Blokpoel was not allowed for example to make a film record of radar screens during classified operations. Similarly, no exact data is available on the number of hours of night flying at Cold Lake Base in 1970, but some flights are known to have been cancelled mainly because of his bird migration forecasts.

Stirling made simpler . . . but still 10 years away

With a research programme stretching back to 1937, Philips has developed the Stirling engine from an inefficient toy into a device which fulfils much of its considerable theoretical promise. In recent years, however, others have taken up the Stirling engine, among them the United Stirling company of Malmö, backed by a group of Swedish companies and by the Swedish government—which is interested in military applications.

United Stirling's managing director, S. G. Carlqvist, recently described to an audience of transport engineers in London how his company has sophisticated the Stirling—while admitting that another 10 years' work is needed to make the Stirling a practical alternative for motorcars.

The Stirling is an external combustion engine of high potential thermal efficiency built around a sealed container, filled with a working gas, which is heated at one end and cooled at the other. The gas is first compressed by pistons in the cold space, then moved to the hot area where it expands and does useful work on one of the pistons. The gas is then moved back to the cold space so that the process can be repeated. Between the hot and cold spaces is a heat store called a regenerator—essential to the efficiency of the engine.

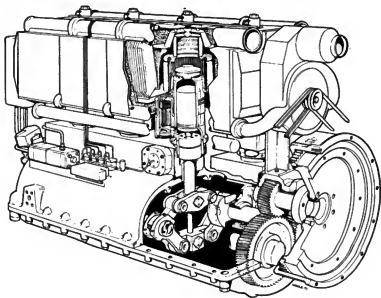
Philips' two main contributions to Stirling engine development were to use low-viscosity hydrogen instead of air as the working gas, and to devise a special "rhombic drive" mechanism to operate the coaxial power and displacer pistons needed. Accordingly, United Stirling's first step was to build

a 200 bhp four-cylinder version of such an engine (see diagram). But the rhombic drive with its two contra-rotating crankshafts although more compact than previous models proved too bulky and the liquid fuel annular burner needed for each cylinder made the engine larger still.

A simpler engine was needed, United Stirling decided, using ordinary automotive parts wherever possible, so they evolved a double-acting engine. In this version, the cylinders are connected in series through their heaters, regenerators, and coolers. By correct phasing, a single piston in each cylinder combines the function of displacer and power generator. Thus a

single conventional crankshaft can be used.

A prototype V4 engine using this principle has been built. The cylinders—and their adjacent heater/regenerator/cooler units—are positioned on the circumference of a circle, as well as inclined in a "V" formation, and so are able to share a single fuel burner. Output so far is around 52 bhp, giving a weight:power ratio of about 6 lb/bhp, but more advanced versions of the engine should produce 100 bhp with a thermal efficiency of 39 per cent. The engines are claimed to be exceptionally quiet, have good fuel consumption and low exhaust emissions, but most important, are now mechanically much simpler than before.



Superplastics flow into production

Superplastics have long been a tempting but seemingly unattainable material for engineers. Superplastic alloys "flow" under the right conditions and can be moulded rather like plastics. The problem has been to find an alloy that is superplastic but strong when formed. Tube Investments and its associate the British Aluminium Company Ltd have formed a new company, Superform Metals Ltd, to exploit a superplastic alloy developed at the TI Research Laboratories at Hinxton Hall, near Cambridge, and the BA Technological Centre at Chalfont Park, Gerrards Cross, Bucks.

Superform will manufacture components in Supral 150, which TI claims is the first practical commercial aluminium alloy with superplastic properties. An important feature of Supral 150 is that it is clad with pure aluminium on both sides. The aluminium makes no difference to the superplasticity of Supral 150, but permits anodising and other finishing techniques, and gives greater corrosion resistance.

The new company is still in its infancy. Production facilities are not yet ready, but should be operating by the summer. Superplastic materials are suitable for products with a limited demand. Superform intends to concentrate on producing limited runs of complex components (for cars, aircraft, and office machinery) which have previously been assembled from a number of simpler parts.

The cost of tooling up is much lower



The kind of components that can be shaped from superplastic materials: low runs of awkward shapes

than for conventional machining—a single mould is needed (so that the superplastic material can be "sucked" on to a male mould or "blown" on to a female mould). The tooling savings are shown by one example that would have cost £20 000 with conventional machining, whereas the cost for superplastic tools was just £800. This makes the technique attractive for low production runs, where the tooling cost can be a high percentage of the total production costs.

New nozzle saves firemen's throats

Firemen will be able to control the rate of flow of water through fire hoses automatically for the first time with a clever piece of electronics devised for US fire departments. At the moment the only way of controlling flow is for the fireman holding the nozzle and directing its play to shout to another fireman on the fire engine pump. In the confusion of a fire, this is not as simple as it sounds.

US fire chiefs are reported to have been impressed by a demonstration of the new device last December in New York. The key element of the system is a collar, 10 cm in diameter, 22 cm long, and weighing 2.2 kg, which is fitted to the hose behind any standard nozzle.

This aluminium/plastic collar is in fact an encoder/transmitter. The fireman simply twists it to regulate water flow, in six increments from 0 to just over 400 l/second. When twisted, the collar sends pulses to a receiver in the pump which activates a governor operating on air from the fire engine's air brakes.

As well as controlling water flow, the device has two safety features. If a hose bursts, the control is arranged so that constant pressure is maintained in any other hoses attached to the same pump. And if there is a drop in water supply, or if the pump overheats or loses oil pressure, two warning systems come into operation. A warning light flashes simultaneously with an audible alarm, and the water supply to the hose is pulsed so the hoseman knows he may be running out of water.

The development work on the automatic controller was carried out by the Grumman Aerospace Corporation, with help from Public Technology Inc., an association of US local government authorities. Grumman expects to market the device in December 1974.



Measuring the noise individuals are exposed to is not easy; a steel worker, for example, may work in a quiet section of a noisy mill. A personal noise meter developed by Du Pont aims to solve this problem. The "audio dosimeter" consists of a 9 volt battery and associated electronics, linked with a piezoelectric microphone worn on the shirt collar. The output of the microphone is fed to an "A" filter which reproduces the sensitivity of the human ear, and then is averaged and converted to a current which is integrated and stored on a re-usable memory cell. When the worker finishes his shift the memory cell is read and the level of exposure displayed as a percentage of a pre-defined limit. The meter measures noise between 80 and 115 dBA and records any exposure to noise over 115 dBA lasting longer than a second.

MUTAGENS

For the large number of technical directors who are aware of the current concern about Mutagens, and who must now decide what action they should take, IRI has prepared a short brief outlining available tests and offering advice on what action to take.

To receive this brief, without any obligation, write, telephone or telex:

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Molecular fossils

Many enzymes bind to nucleotides while they carry out their catalytic function. During evolution, the part of their structure involved in this binding has changed relatively little, amongst a diverse selection of essential proteins. This permits their common ancestry to be traced to a pre-cellular origin

Professor Michael Rossmann

works in the
department of
biological sciences,
Purdue University,
West Lafayette,
Indiana

In 1912 Sir Lawrence Bragg solved the first structure of a crystal in terms of its atomic positions by comparing the similar, isomorphous, X-ray diffraction patterns of sodium and potassium chloride. His work was quickly followed by other researchers, and thus was established a completely new and powerful analytical tool. Twenty-five years later, at the Cavendish Laboratory in Cambridge, Bragg and his assistant, Max Perutz, started looking at the crystal structure of haemoglobin. This is a protein of 68 000 molecular weight containing four polypeptide chains each with roughly 150 amino acids. In spite of the advances that had been made by then in the use of X-ray crystallography, many considered such a project ridiculously ambitious. In 1953, however, Max Perutz adapted the isomorphous replacement technique, first used in 1912, to protein problems, and thus initiated a revolution in our knowledge of biological structure.

After listening to a lecture on protein structure by Dorothy Hodgkin, from Oxford University, at an international meeting held in Montreal in 1957, I resolved to participate in this work. It was an opportune moment for such a decision, as computer technology had just started to bring the solution of proteins within sight. Indeed John Kendrew, a student of Max Perutz, had tentatively suggested a crude structure of myoglobin (which used to be called muscle haemoglobin) that same year. I then started to work in Cambridge with Max Perutz. In August 1959 the beautiful structure of haemoglobin emerged from our electron density maps. To the amazement of all, it turned out to be essentially four myoglobin molecules associated with each other. Quickly it became apparent that the function of a protein significantly regulates its structure, even if the amino acids along the polypeptide chain change almost beyond recognition. There must have been a precursor protein with the ability to bind haem, from which could act as an oxygen carrier, from which all modern oxygen carriers have evolved.

Cambridge soon became a Mecca for many young scientists who, like me, eventually set out to develop their own laboratories, mostly outside Britain. Thus during the last decade there has been an explosion in the number of known protein structures. Although a certain degree of order has become discernable—in that some families of protein structures have started to emerge (for instance the globins)—the rapidly increasing number of known structures are mostly unrelated to each other. Recently, however, structural and amino acid studies of dehydrogenases have revealed an underlying pattern in the binding of nucleotides to proteins. Not only does such a function go beyond the immediate family of dehydrogenases, it also explicitly demon-

strates the conservation of structure where there is need to conserve function.

In 1964 I left Cambridge and set up my own laboratory at Purdue University in America. I chose as an object of study the molecule lactate dehydrogenase (LDH), which is involved in glycolysis. (The breakdown of sugars by glycolysis is the oldest biological process for obtaining energy for cell processes.) A few years previously it had been shown that LDH exists in at least two different genetic variations, according to the type of tissue examined. These two different polypeptide chains could combine with each other to form five distinct tetrameric isozymes. This suggested that they are structurally similar, perhaps due to their close functional relationships. Furthermore, dehydrogenases form a large family of enzymes which require coenzymes such as nicotinamide adenine dinucleotide (NAD) or flavin adenine dinucleotide (FAD), with respect to which a hydrogen atom is shuttled to and from the substrate. Some dehydrogenases (such as liver alcohol dehydrogenase, L-ADH) also require a metal atom for catalysis or merely for structural stability. These enzymes participate in a vast variety of metabolic processes both in the cytoplasm and whole bound to cell membranes. Thus if there were any common structural basis amongst dehydrogenases in general it must have arisen due to common chemical requirements in diverse metabolic pathways.

Nate Kaplan, who was at Brandeis University in 1964, allowed me to look through his LDH extracts taken from many different species. I was surprised by the beautiful cube-like crystals in a dog-fish preparation which gave far better X-ray diffraction photographs than the pig LDH crystals I had previously used. Nevertheless, it was not until 1970 that the three dimensional structure was solved, and only in 1973 that Susan Taylor in Nate Kaplan's laboratory (now at the University of California in San Diego) completed the amino acid sequence. A good deal of the time was taken in setting up versatile equipment for data collection and in writing useful computer programs. The weekend in which Margaret Adams, Paul Lentz, Alex McPherson, Richard Schevitz and I deciphered the first 2-8 Å resolution LDH electron density map made all the intermediate struggle worthwhile.

It was apparent that 35 000 MW subunit of LDH consisted of two parts. The first was associated with the binding of the NAD coenzyme. The second was involved in binding the substrate, providing residues for catalysis, and giving the structural requirements for substrate specificity.

The NAD binding fragment could itself be divided into two similar parts related by an approximate two-fold axis. Each of these two

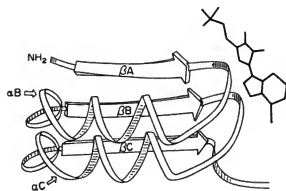


Figure 1 Diagrammatic representation of the polypeptide fold in mononucleotide fragments found in LDH, s-MDH, flavodoxin, L-ADH, GPD, and also probably in PGK, muscle kinase, rhodanese, and glutamate dehydrogenase. About 60 amino acids are involved in this structure. The approximate position of a bound AMP is shown

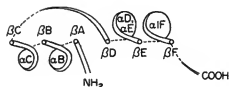


Figure 2 Diagrammatic representation of the six stranded parallel β -pleated sheet and connecting α -helices found in LDH, s-MDH, L-ADH, GPD. It is similar to the structure found in PGK and muscle kinase. In the dehydrogenases this binds the dinucleotide cofactor NAD in an open conformation. The structure is viewed from the amino end of the sheet. The labelled nomenclature has been used in the dehydrogenases to describe different parts of the structure. Helices are term α B, α C, α D . . . while sheets are β A, β B . . . in sequence along the polypeptide chain

domains is associated with the binding of a mono-nucleotide; thus together they bind the dinucleotide cofactor. The mono-nucleotide fragment is shown diagrammatically in Figure 1, while the two domains together are illustrated in Figure 2. They form a six stranded parallel sheet with two helices on either side. It might also be noted that this structure has "a hand" to it.

In 1972, Len Banaszak of Washington University in St Louis presented the structure of soluble malate dehydrogenase (s-MDH) at the international protein crystallography meeting arranged by Max Perutz at Alpach in the Austrian Alps. He had been able to show that the subunit of s-MDH was essentially identical to that of LDH, although the s-MDH molecule is a dimer, not a tetramer like LDH. This was the first indication that a system of similar structures might indeed be present amongst the dehydrogenases.

At the same meeting Lyle Jensen of the University of Washington in Seattle and Martha Ludwig of the University of Michigan

in Ann Arbor both presented independently the structure of flavodoxin, a little electron transfer protein that occurs in bacteria. After Lyle Jensen had finished speaking, I ventured to remark that his structure reminded me strongly of part of the LDH structure (Figure 1). Later, after returning to Purdue University, S. T. Rao and I investigated this relationship further. We found that flavodoxin and LDH were truly similar and that flavin mononucleotide bound to flavodoxin in a manner resembling the binding of each nucleotide to LDH. I also discovered that biochemists had in fact suggested common properties to flavin and adenine nucleotide linked proteins. If these facts had been known to the crystallographers in Alpach then my remarks after Lyle Jensen's talk would have been less surprising.

In March 1973 I received a very excited letter from Carl Brändén of the Royal Agricultural College in Uppsala, Sweden. After a 10 year battle with all manner of problems, he had just arrived at the solution of liver alcohol dehydrogenase (L-ADH). He found that the NAD cofactor bound to the protein in a manner closely resembling that in LDH. However, the other part of the structure, more related to the substrate requirements, was quite unlike LDH. Carl Brändén predicted in his letter that other NAD linked dehydrogenases would also contain the same dinucleotide binding fragment.

In April of 1973 the structure of glyceraldehyde-3-phosphate (GPD) was determined in my laboratory by Manfred Buehrer, Geoffrey Ford, Dino Moras, Ken Olsen and myself. We had supplemented the isomorphous replacement method by the molecular replacement technique, one I had first suggested in 1960. By 10.30 pm we had stacked all the electron density sections and were ready to interpret the map. None of us could go home; we were all far too excited to find out whether our novel crystallographic techniques had worked, and above all to find out what this structure would tell us.

This was the first NAD linked enzyme to be examined crystallographically which reacted on the "B side" of the nicotinamide ring, whereas LDH, s-MDH and L-ADH are all A side specific. Furthermore both fluorescence quenching and NMR studies suggested the dinucleotide would be "closed", with its two bases parallel. It seemed improbable that Carl Brändén's prediction would be valid in this case. It was one of the most memorable occasions when we all realised in the early hours of the next morning that we had discovered once again the dinucleotide binding fragment, and that the NAD coenzyme was open as it also is in LDH. The remainder of the subunit structure of GPD was different and related to the properties of its specific substrate.

It was now possible to start to draw an evolutionary tree, such as is shown in Figure 3. Presumably there first developed a mononucleotide binding fragment, which by gene duplication produced a dinucleotide binding protein. This was in turn copied and each copy, when combined with another gene, gave rise to a different dehydrogenase. The early

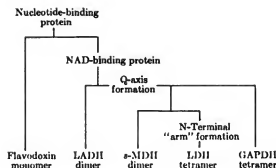


Figure 3 Evolutionary tree relating various dehydrogenases and flavodoxin. The "Q-axis" relates to a subunit-subunit contact present in some dehydrogenases and not in others

necessity for a protein able to bind nucleotides can be hypothesised both for the purpose of replicating genetic material and for its role in energy transferring pathways such as glycolysis. As biological cells require for their proper functioning essential metabolic pathways and their component enzymes, the evolutionary tree in Figure 3 must bridge the gap from pre-cellular to cellular biology.

Armed with such a hypothesis, my colleagues and I reported our results at the International Biochemistry Congress held in Stockholm last year. Before the meeting, I visited laboratories in Oxford and Bristol, where the molecule of phosphoglycerate kinase (PGK) is being studied by Colin Blake and Herman Watson and their associates, respectively. This molecule is another enzyme involved in glycolysis and uses the nucleotides ADP and ATP as cofactors. I was shown the new electron density maps and saw that these structures were consistent with the hypothesis. Colin Blake and Phil Evans had been able to demonstrate that one of the two lobes of this molecule was the ADP binding protein. An ADP molecule would bind to this lobe in a manner closely resembling the situation in dehydrogenases (Figure 2).

In Stockholm Georg Schultz and Heine Schirmer from the Max Planck Institute in Heidelberg presented their structure of adenylate (muscle) kinase, which if not identical, certainly is exceedingly similar to the NAD binding fragment in the dehydrogenases. Tom Steitz from Yale University also gave some preliminary results on the structure of hexokinase. Although his work is not

yet completely interpretable, the indications are that the subunit of hexokinase may be similar to that of PGK.

The structure of rhodanese was presented in Stockholm by Jan Drenth, Jan Derik Smit, and others from Groningen in Holland. Rhodanese is a common protein of unknown function found in higher organisms as well as prokaryotes. For me the major interest was that it showed the mononucleotide fold (Figure 1). It has turned out that this protein binds many nucleotides. The Dutch researchers are now investigating whether these bind in a manner similar to that predicted by the structural suggestion. If this is the case, then reasonable guesses as to the function of this protein can be made and tested.

Amino acid changes (or alternatively the corresponding base changes of the genetic code) between the same protein found in different species have been used by Emanuel Margolish and many others to study evolutionary divergence between species. In general if the number of amino acid changes are large—that is, if the number of accepted mutational events that have been able to take place is great—then the divergence from a common node in the phylogenetic tree had occurred a long time ago.

After returning from Sweden last year, Dino Moras, Ken Olsen and I aligned the structures of the nucleotide binding proteins and compared the amino acid sequences. We are therefore studying the evolutionary distance between enzymes which probably diverged from a common ancestral protein at a time when explicit biological cells did not exist. Our findings are briefly summarised in Table 1, where probable times for the events have also been indicated.

In this way we were able to establish a pattern of amino acids in nucleotide binding fragments. Emil Smith and his co-workers had determined the sequence of the 500 amino acids of glutamate dehydrogenase. Within this sequence we found one region which had the same pattern and should thus relate to the structure shown in Figure 1 and have the function of binding NAD or NADH. This is therefore an example where we can readily make a structural prediction on the basis of sequence alone.

The nucleotide binding protein might be expected in such various fundamental molecules or aggregates as amino acid t-RNA synthetases, ribosomal proteins, and virus coat protein. These structures are now being investigated in different laboratories. My own laboratory, for instance, has made progress in studying a small spherical plant virus (Southern Bean Mosaic Virus), a particle of molecular weight 6×10^6 Daltons. Similar investigations of viruses are in progress in Uppsala, Harvard, and Cambridge.

With the every accelerating rate of protein structure determinations, it should soon be possible to recognise the structure-function relationship of many, if not most, polypeptide domains. Significant new insights into biochemical problems should rapidly occur with such a unified concept of the origin, evolution, and function of protein structure.

Table 1
Minimum base changes per codon between various nucleotide binding proteins of known sequence and structure

| Note | Approximate time (10 ⁶ years ago) | Minimum base changes per codon |
|-------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------------|
| 1 bovine—chicken | 0.3 | 0.03 ± 0.03 |
| 2 pig—lobster | 0.6 | 0.43 ± 0.06 |
| 3 yeast—pig or lobster | 1.2 | 0.59 ± 0.03 |
| 4 origin or dinucleotide binding fragment in dehydrogenases | 1.2–3.2 | 1.14 ± 0.04 |
| 5 origin of mononucleotide binding fragment in dehydrogenases | 2.2–4.0 | 1.33 ± 0.03 |
| 6 mononucleotide binding fragment in flavodoxins with those in dehydrogenases | 3.2–4.5 | 1.42 ± 0.03 |
| 7 random changes | 4.5 | 1.52 ± 0.1 |

Unlearning visceral learning

Psychologists were astounded when New York researchers demonstrated that humans and experimental animals could alter their heart rate, apparently at will. The nature of the phenomenon—known as visceral learning—is now being questioned because of data from recent new experiments

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The area I want to discuss has been given several names: "the operant conditioning of internal responses"; "the production of voluntary control over internal responses"; and "biofeedback". Whatever the name, the basic idea behind this research is simple. One selects procedures that have been employed in the past to train observable responses. Then one employs these procedures to train internal responses which the experimenter cannot observe directly, and of which the subject himself is often unaware. For instance, one might select a simple form of operant conditioning in which the probability of occurrence of an observable response is increased by presenting a reward immediately after the response occurs. An example is the procedure of presenting a food reward to a hungry rat when it makes a correct choice in a simple maze. Then one could employ this procedure to train an internal response by presenting a food reward to a hungry rat each time it performs an internal response, such as elevating its blood pressure.

The first points that I would like to make are these. The operant conditioning of internal responses is not a unitary phenomenon, and we know more about certain aspects than others. The training procedures employed range from the simple operant conditioning described above, through complex procedures that are employed in teaching motor skills, to procedures that are designed to establish "voluntary control". We know a great deal more about simple operant conditioning than about procedures for establishing "voluntary control", or for that matter, about what we mean operationally by the term "voluntary control". The same point may be made about the responses that have been trained. They fall into three classes: responses controlled by the autonomic nervous system; the electrical activity of muscle (EMG); and the electrical activity of the brain (EEG).

These responses differ in a number of respects; probably the most important is there amenability to operant and voluntary control. No one, I think, seriously doubted that EMG responses and some types of brain electrical activity could be operantly conditioned. After all, every time a rat runs in a maze it makes EMG and brain electrical activity responses. To the extent that given patterns of brain electrical activity and EMG are components of the neurobehavioural system that controls running, a subject could learn to perform each type of response simply by activating that system. On the other hand, most responses that are controlled by the autonomic nervous system were thought to be components of regulatory systems not amenable to operant and voluntary control.

For those who accepted this position, the demonstration of operant and voluntary con-

trol over autonomic responses would occasion not only surprise and disbelief, but also some apprehension about tampering with the basic regulatory mechanisms of the body. I have emphasised these differences among internal responses because I shall discuss only the operant conditioning of autonomic responses, and the conclusions which I shall reach do not necessarily apply to EMG and brain electrical activity.

Given the beliefs about autonomic responses, it is not surprising that the initial objective of research on the operant conditioning of autonomic responses was to find out whether these responses really could be brought under operant control. The data, particularly on heart rate, were encouraging. Both animal and human subjects could be trained to increase heart rate for a given reward and to decrease it for the same reward. And they achieved this without resorting to muscular exercise.

It was Neal Miller, Leo di Cara, and their associates at the Rockefeller University, New York, who demonstrated the change in heart rate in the absence of muscular exercise. They carried out their research on rats whose skeletal muscles had been paralysed by a curare-like drug, d-tubocurarine chloride. This drug blocks transmission at the junction between efferent nerve and skeletal muscle so that the rats could not move (and had to be artificially respiration), but they could receive sensory information and process that information centrally. The main results of this research can be summarised as follows. First, they demonstrated the operant conditioning of increases and decreases in a variety of autonomic responses in curarised rats, such as heart rate, blood pressure, vasomotor responses, intestinal motility, and renal blood flow. Second, they showed that operantly conditioned heart rate changes were specific. Conditioned heart rate changes were not correlated with changes in intestinal motility and conditioned changes in intestinal motility were not correlated with changes in heart rate. Furthermore, conditioned heart rate changes were not correlated with changes in movement after recovery from curare. Third, an unexpected result, heart rate conditioning was better in the curarised state than in the normal state.

The demonstration of autonomic operant conditioning in the curarised rat was impressive. Even more impressive, perhaps, was the specificity of conditioning. The fact that one autonomic response was conditioned without correlated changes in another autonomic response and in skeletal responding suggested that skeletal mediation could not account for all operant autonomic conditioning.

The independence of heart rate and skeletal activity was questioned, however, because of

data which did not agree with Miller's. In experiments that we carried out on the operant conditioning of heart rate increases and decreases in partially curarised dogs, heart rate changes were conditioned, and were highly correlated with EMG changes. ("Partially curarised" means that we could observe no gross movement but could record the electrical activity of the skeletal musculature (EMG). In subsequent experiments dogs were operantly conditioned to increase heart rate while partially curarised. Then, the level of paralysis was increased until no EMG was recorded, and the ready signal which elicited the conditioned heart rate increase was presented. Finally, the dogs were allowed to partially recover from the effects of curare, and the ready signal was presented again.

In most cases, heart rate responding was attenuated by deep paralysis, probably because large doses of d-tubocurarine chloride usually block neural activity in peripheral autonomic ganglia; but in a few cases, heart rate responding continued when EMG was absent, even though EMG and heart rate changes were correlated before and after recovery from complete paralysis. In short, when movement could occur, it was correlated with changes in heart rate; when movement was blocked peripherally, heart rate changes continued to occur sometimes. This led us to conclude that heart rate changes were correlated with the activation of central components of movement control circuits. That is, there is a central link between circuits controlling movement and heart rate; the paralysed dog could therefore produce heart rate increases by activating central components of movement control circuits—that is, by "attempting to move" while paralysed.

Heart rate and movement

Wendell Goessling and Jasper Brener, then working with rats at the University of Minnesota, reached conclusions that were similar to ours. They first trained one group of rats to move and another to remain immobile in the presence of ready signal in the normal state. Then they curarised the rats and attempted to operantly condition heart rate increases and decreases to the same ready signal. The changes that occurred to the signals under curare were determined more by the previous movement training in the normal state than by the operant heart rate conditioning under curare.

This disagreement about the relationship of heart rate changes to movement was not resolved because a more serious problem arose. Neal Miller and Barry Dworkin, and then later Leo di Cara, reported that they could not replicate their results on the operant conditioning of heart rate under curare. Then, more recently, they reported that the work on intestinal contractions could not be repeated. Although they had some earlier success Jasper Brener and William Hahn and Larry Roberts (all at McMaster University, Canada) also reported recent failures to operantly condition heart rate in curarised rats.

This failure to replicate previous experiments forces us to raise questions once again

that we thought were answered. We do not know whether autonomic responses are amenable to operant conditioning in curarised rats, and if some are, which ones can be operantly conditioned. We do not know how specific operant conditioning is. We do not know whether operant autonomic conditioning is really of greater magnitude in the curarised rat than in the normal animal. There is no doubt, however, that there are limitations on the magnitude of the changes in heart rate than can be produced by operant conditioning in the normal subject as one would expect of a regulatory system which is under powerful homeostatic control. In this sense, the traditional belief that autonomic responses are less amenable to operant control than skeletal responses may not be far off the mark.

Although these questions must be raised again, especially when so many thought them to be safely answered, it is important to realise that we are not back to square one. Real progress has been made on some problems. Let me try to summarise where matters stand at present. First, there is no doubt that heart rate changes can be operantly conditioned. In addition to the evidence on heart rate conditioning in the normal and partially curarised animal that I mentioned above, positive results have been obtained by Bernard Engel (at Baltimore City Hospital) in non-curarised monkeys, and by a number of experimenters in human subjects. Blood pressure and peripheral skin temperature changes have also been operantly conditioned in human subjects. At the same time we do not know how subjects produce these changes. For example, we do not know whether subjects can be trained to produce cardiovascular changes without at the same time producing changes in the central components of neural circuits that control skeletal movements. We are attempting to answer this question now, by training rats to produce heart rate changes while they are simultaneously required to remain immobile. Similar questions about the strategies employed by subjects to produce operantly conditioned changes in skin temperature can be raised.

Second, in order to provide information on the strategies employed to produce operantly conditioned autonomic changes, measures were taken of changes in other indices of autonomic function, central nervous system activity, and behaviour that occurred concomitantly with the operantly conditioned autonomic change. This research has increased knowledge of how the autonomic nervous system functions.

Third, some therapeutic applications have been discovered. Bernard Engel, for example, has shown that the operant conditioning of reductions in heart rate variability has helped patients suffering from cardiac arrhythmias. These accomplishments are real. At the same time, there is no doubt that the claims that have been made for the operant conditioning of autonomic responses, especially in the popular press, are overblown in the light of the scientific evidence that is available at present.

The energy equations



Wood fuels the developing world

Many countries still rely upon wood as a major source of fuel, and as the price of oil rises wood fuel will become even more important. Without a proper programme of planting and harvesting the poor nations of the world could face an energy crisis that dwarfs today's disturbances

Keith Openshaw

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The energy crisis in "Third World" countries is at least as serious as the much publicised problems of the developed nations. Most of the population in the developing countries are peasants living in a subsistence economy. Their energy requirements for cooking, heating, protection (a fire keeps away unwanted insects and wild animals), and cottage industries are met almost entirely by burning wood which is freely collected from the surrounding countryside. Their urban counterparts also depend on woodfuel, mainly in the form of charcoal, for their everyday energy needs.

Over 95 per cent of households in developing countries, where woodfuel is readily available, use it as a primary source of energy. This falls to about 80 per cent when all developing countries, including wood poor regions and desert countries, are counted. Likewise industry in these countries such as brick and ceramic manufacture, fish and tobacco curing, cassava meal, rubber, sugar and wattle tanning production, restaurants, tin smelting, and steel manufacture all use woodfuel to a varying degree.

In areas of good wood availability, only dead branchwood is collected, but where shortages occur young saplings are taken, and eventually mature trees are felled especially by the "urban" charcoal producer who requires large quantities of raw material within an economic transport distance of the urban centres.

The demand on woodlands and forests has led to denudation of the land in certain areas. In consequence the population has either to move on or make do with substitutes such as cattle dung, to the detriment of the soil. The removal of the vegetation cover has also

increased soil erosion which, at least, causes loss of topsoil and, at worst, results in massive flooding in river valleys and delta regions. The principal cause of the recent floods in the Indian sub-continent was the removal of tree cover in the catchment areas for fuelwood (and shifting cultivation). Likewise, the continual cutting of fuelwood in the Southern Sahara/Sahel region of West Africa has facilitated the rapid shift southwards of the desert, and has made living in this area even more precarious.

For the past five years the FAO has undertaken wood consumption surveys in East and West Africa and in South-East Asia. The main emphasis of these surveys was to determine consumption of industrial wood—sawnwood, panel products, and paper—and to forecast future requirements so that meaningful plans could be made for the development of the forest and forest industries. Nevertheless, all forest products were considered and in each country the present and impending shortages of woodfuel in the different regions was the most urgent problem.

These surveys (see Table) indicate, if projected to all the developing countries, that although woodfuel enters the industrial process in a minor way, it accounts for over 85 per cent or about 2000 million tons (air dry) of total annual wood consumption. Indeed for the world as a whole woodfuel represents about 65 per cent (2300 million tons) of 1972 wood use. This wood is equivalent to burning 1300 million tons of coal.

On a per capita basis, average consumption in developing countries is just over 1 ton per year but this increases to 1.3 tons/year, or 8 tons per family per year when only those who use wood are counted. As the wealth

Woodfuel consumption in some developing countries

| Country | 1973 GDP per capita £ | Percentage of GDP derived from subsistence sector | Consumption of woodfuel per capita/yr | | Woodfuel consumption out of total timber consumption % | Population using woodfuel % | Charcoal consumption out of total woodfuel consumption % | Urban population % |
|----------|--------------------------------|---------------------------------------------------------------|---------------------------------------------|------|-----------------------------------------------------------------------|--------------------------------------|-------------------------------------------------------------------------|--------------------------|
| | | | ft | tons | | | | |
| Tanzania | 40 | 30 | 80 | 1.8 | 96 | 99 | 4 | 7 |
| Gambia | 50 | 25 | 56 | 1.2 | 94 | 99 | 26 | 23 |
| Thailand | 80 | 20 | 48 | 1.1 | 76 | 97 | 45 | 15 |

of the population increases there is a switch to fuels other than wood, especially in urban areas. Therefore average per capita consumption is decreasing slightly but in absolute terms population increase is increasing total demand at a rate slightly less than the population growth of the developing world, or about 2.5 per cent per year. However, because of existing shortages consumption is increasing at a somewhat slower rate than the projected growth in demand. In other words there is an excess in demand over supply which will continue and widen if nothing is done to correct it. In practical terms this shows itself in a number of ways: ever increasing time spent on collecting fuelwood; price increases; and the cutting of living trees (first saplings and finally mature trees), leading eventually to the two extremes—an increase in desert areas or calamitous flooding.

The shortfall of supply over demand leads to a reduction in area and volume of the forests and woodlands. While a temporary decrease in forest capital can be made good, a continual decrease will lead to disaster not only for the developing countries but for the whole world, because the forest and woodland vegetation are a considerable source of oxygen and the developing world's woodlands make up 50 per cent of the total forest area.

With proper planning, the shortfalls in supply could easily be reversed. Fuelwood plantations could be grown on a 6 to 10-year rotation using such species as Eucalyptus, Indian neem and Gmelina, giving an average annual yield of about 8 tons per acre (including branches)—enough for an average family. As plantations are far more productive than the forests and woodlands, the latter could be cleared for other uses (including plantations) without sacrifice. Such plantations if grown for the non-subsistence sector of the community could yield about 5 per cent per year on invested money, assuming a selling

price of 80 pence a ton for the standing tree (1.6 p/cu. ft). It would also provide many rural people with cash income from plantation work and the manufacture of charcoal.

However, fast growing plantations could also meet some of the energy requirements of the Western world. We could not only rediscover the use of fuelwood, charcoal, and the by-products of charcoal manufacture, but also use wood fibre, a renewable resource, as a raw material for the petroleum and allied industries. Already work is being undertaken, notably in the US, and a pilot plant has been established to produce petrol with a low sulphur content. Whether such a plant is a commercial proposition depends very much on the price of crude oil. With current technology a ton of woodfuel can produce 2 barrels of oil. At an oil price of \$10/barrel this wood-to-oil process becomes competitive. Because of favourable climatic conditions and relatively low labour costs, many areas of the developing world could be in a position to enter this market with large scale short rotation forest plantations.

However, the immediate need of these countries is to solve their own energy crises, and by and large they have not enough trained personnel or resources to undertake in many instances massive plantation schemes. "Soft" loans, especially when they are not tied to capital intensive equipment, may be hard to obtain, particularly with today's high interest rates; but they can be justified on ecological grounds, rural employment, and long term economic terms. Therefore, it is not only essential but also in the interest of mankind that the rich nations provide trained personnel, aid and loans to help solve this problem. The developing countries could then play a much greater role in meeting the energy needs of the whole world instead of being in a position where they have insufficient resources to supply their own requirements.



Tree clearing in Sri Lanka—trees are a significant fuel source in many developing countries, without programmes for planting and harvesting the future of this energy source could be bleak

Forum

Westminster scene

Crisis realities

Like other MPs, I have been tramping around industrial managements in my constituency trying to ascertain the reality of the crisis—which is considerable. However, a number of us have separately come to an odd conclusion. Electricity is not the most immediate source of concern. In fact, it is shortage of steel, shortage of oil-related products, and shortage of materials for packaging. One major food manufacturer is anxious that Polythene should be allocated only to those manufacturers who really need it for purposes of hygiene, and denied to those who use it for wrappings for luxury goods. Cardboard and paper present problems.



Miss Joan Quennell (Petersfield) has been interested in the progress in research into methods of de-inking waste paper, in view of the world shortage of woodpulp. Anthony Grant, Under-secretary at the DTI, has told her that a major paper manufacturer is successfully operating de-inking plant for the production of newsprint from waste paper. The department is shortly hoping to place a preproduction order for a new, UK developed de-inking system. This arrangement, Grant claims, will enable it to be evaluated by another leading paper manufacturer. The development of a de-inking system is therefore being pursued actively by industry, but other resources are available, such as those of PIRA—the Research Association for the Paper, Board, Printing and Packaging Industries—should specific problems arise. Once the de-inking process is seen to be a success, then the case for more careful collection of waste paper by local authorities, perhaps with some financial incentive, will be complete.

A growing number of MPs think that there ought to be a price available for bags of clean waste paper, collected in our homes. The only trouble would be when it was discovered that people in the positions of MPs and journalists receive so much unasked-for paper that they could make a personal profit out of their official jobs. Or perhaps the volume of unwelcome material through the post would diminish?

★ ★ ★

Michael McNair-Wilson (Walthamstow East) has been concerned about noise in the machine tool industry. The new Under-secretary at the Department of Employment, Nicholas Scott (Paddington

South), the late Iain MacLeod's last Parliamentary Private Secretary, welcomed the opportunity to announce, during his first appearance on the Front Bench, that a draft code of practice for the reduction of machinery noise had now been prepared. It was drafted by an expert working group set up by the noise sub-committee of the Industrial Health Advisory Committee.

This document is being sent out to many industrial organisations, including representative bodies of the machine tool industry. MPs are assured that any representations received by 31 March 1974 will be carefully considered in the preparation of the final version of the code. If you are directly concerned in this problem, I do advise you not to neglect your opportunity.

★ ★ ★

MPs interested in nuclear matters welcome the application by the CEGB to Lord Carrington for consent and a nuclear site licence for a new nuclear power station on the Dungeness site in Kent. The idea of a nuclear complex, or in Alvin Weinberg's phrase "a nuclear park", has its attractions. For one thing, it is likely to be more sensible from the general amenity point of view of the country; for another, it means that nuclear construction engineers can settle in one place for a few years, and provide some chance of coherent schooling for their children. At Dungeness, the application is for a third station of about 3900 MW capacity. The proposed unit will require a 400 kV overhead transmission line from Dungeness via the electricity sub-station at Lydd to connect with the existing supergrid system south-west of London. (The proposed line will be the subject of local authority consultation and a separate application for consent.) In the meantime, congratulations to Sizewell nuclear power station (between Aldeburgh and Southwold on the Suffolk coast) for being the first winner of the Hinton Cup, given for being the cleanest and tidiest power station in 1973—though what criteria are used in reaching a decision, by nature so invidious, I know not!

★ ★ ★

On Christmas Eve I wrote to Sir Alec about the purchase of enriched uranium from the Russians; some members of the EEC have already signed contracts. Now the Foreign Office tells me that, after the early 1980s, it is expected that Europe will be capable of self-sufficiency in enriched uranium when the French gaseous diffusion, and the British-Dutch-German gas centrifuge enrichment plants come on stream. In the meantime, I understand from the Foreign Office that European purchasers would have been happy to have continued with their traditional purchases from America, but that the revised US Atomic Energy Commission contract terms now stipulate unacceptably long lead times. We are in the fortunate position, however, of having our own supply of enriched uranium,

and have not had to consider the Russians as potential suppliers.

Peter Emery, of the Ministry of Energy, has told Dr John Cunningham (Whitehaven) that the Council of Ministers of the European Communities, set up in May 1973, issued a report in November which indicated that it was unable to arrive at a unanimous view on the strategy to be employed for the development of a European enrichment plant capacity. The current position is that the Commission of the European Communities has put proposals on enrichment to the Council of Ministers, which has not yet met to discuss them. Meanwhile, in collaboration with Germany and Holland, the UK is vigorously pursuing the tripartite centrifuge project, with the intention of having installed capacity of 2000 tonnes per annum in 1980.

We MPs are keeping our collective fingers crossed that the sour relations which are currently pervading EEC discussion on regional policy and whose oil it is in the North Sea, don't spill over into hitherto satisfactory technical co-operation. I sometimes wonder whether the old idea of the late 60s of a European Technological Community would not, for all its seeming wooliness, have provided a better start in solving the problems which really matter, than the Treaty of Rome. But enough of such heresy, or is it apostasy?

★ ★ ★

One of the difficulties of a major crisis is that it obscures other important items of news, which would otherwise get the attention they deserve. MPs are becoming increasingly uncomfortable about student grants, where many who are not sustained by better-off parents are on the edge of real poverty. An unpopular cause, but one which should not go by default.

Tam Dalyell MP

Washington view

Yawn over energy plans

The budget that the President has just sent to Congress for the fiscal year that starts on 1 July contains a great expansion of funds for energy research and development—some 75 per cent more as compared with present annual spending by the federal government, to give a total of about \$1.6 thousand million, depending upon what's counted as energy R&D. Nice numbers, in view of the energy crisis, but though a few years ago such sums would have been hailed as a sign of government foresight and capacity for heading off problems before they become too painful, the reaction here (based on pre-publication circulation of the budget figures) is subdued.

The reason is that, along with many other one time durables of national public affairs, the annual federal budget has

come to be regarded as more of a public relations gimmick than a genuinely believed blueprint for allocating federal resources. Nixon does not deserve all the credit for washing away public confidence in the significance of the budget. Both Kennedy and Johnson occasionally employed the annual extravaganza of unveiling the budget—it takes place in an auditorium before hundreds of reporters—to proclaim new departures in federal activities, with subsequent events demonstrating that they never left the station. Thus, in the final year of the Kennedy administration, the scientific community broke into cheers when the budget revealed that the administration sought a near-doubling of funds for the National Science Foundation. Congress squelched that plan, as the administration had every reason to expect it would. Johnson's designs for education and anti-poverty programmes often read well in the budget, but a retrospective look shows that expenditure often fell far short of forecasts.

The generally restrained response to Nixon and his ambitious energy R&D spending plans can be traced to extensive previous experience with this President's budgetary embrace of popular causes. Two years ago, before the energy crisis manifested itself at the local gas pump, Nixon's science office put together an energy R&D programme that was officially embraced by the President as the master plan for dealing with the problem. The science office is now defunct but, according to several of its alumni, virtually nothing was done about putting the proposed programme into effect. As one of them put it, the President said some kind words, he reaped a good deal of favourable press notice, and then nothing happened.

It will be argued, of course, that the crisis has arrived in so emphatic a fashion that it is inconceivable that the newly announced spending plans for energy R&D will turn out to lack durability. There should be no doubt that good intentions prevail all across the political spectrum—from the White House to Congress to the various executive agencies that will dispense the funds for energy R&D. The difficulty is, however, that the US political process pulsates to the rhythm of congressional elections every two years and a presidential election every four years. And every year brings budgetary crises and wrangling between Congress and the White House—even when they are controlled by the same party—as to who is responsible for overspending or underspending, depending on whose favoured programme is at stake.

In this context of skirmishing over an annual budget, with an election never more than two years away, energy research is peculiarly vulnerable. The payoff from the fast breeder or fusion research is many elections beyond its incumbency, and though the necessity for these programmes looms big in national politics at the moment, it is not difficult to compose a scenario in which the sense of necessity is substantially reduced.

For example: energy conservation

takes hold and eases to some significant extent the requirement for imported oil; at the same time, the oil producers ease up on their embargo and expand their exports; in addition, alternative fuels, principally coal, begin, if only slightly, to replace some oil consumption. Publications then flock to be out first with an article titled, "Whatever happened to the energy crisis?" At which point, the White House budget makers are sweating over the figures for the oncoming fiscal year, and it occurs to them that it really doesn't make much difference whether the fast breeder demonstration project comes on line in 1985 or 1987, or whether fusion first powers an electric torch in 1998 or 2016. A cutback in annual expenditures, they will reason, will still permit the work to progress, but at a slower pace. Meanwhile, funds will be released for activities that will bear politically visible fruits in the short term.

It's all happened before, so many times, in fact, that there is no reason to be surprised at the ho-hum response to the administration's long term plans for big spending on energy R & D.

Dan Greenberg

West Coast scene

Whales on parade

Residents of North America's west coast are now enjoying what some call "the greatest free show on earth". It's not exactly free, but for three dollars you can board a commercial boat in San Diego, Oceanside, Newport Beach, or any of the other numerous boat harbours for a two-hour trip in search of the great leviathans. Every year in January and February, California grey whales migrate down the coast in twos and threes from their summer feeding grounds in the Arctic to their winter breeding grounds in Mexico. Many of the whales come within a quarter mile of the surf zone. In a single day as many as 75 whales can parade within spouting view of spectators on the shore. Present estimates of the grey whale population range from 6000 to 18 000. They are making an encouraging recovery considering that the population was almost wiped out in the 1930s, due to intensive whaling.

The grey whales are not as large as their cousins, the sperm whales, and the right whales, but they contain sufficient quantities of oil for good profits when whaling was in its prime. Of all the whales, the grey whales follow the most predictable migrations, making them more susceptible to the whale's harpoon. After gorging themselves on the copious tiny marine animals in the Arctic waters, the greys head for the shallow lagoons on the coast of Baja California, where they mate or, in the case of pregnant females, give birth to calves after a one-year gestation period. The 19th century whaling vessels blocked off the narrow entrances to the lagoons and systematically slaughtered the whales. The most famous of the California whaling captains was one Charles Melville Scammon. From the bridge of the *Mary Helen*, he directed

the assault on hundreds of whales. Due to his success, English-speaking mariners refer to the main grey whale lagoon as Scammon's lagoon, although Mexicans still call it by its original name, Laguna Ojo de Liebre—Eye of the Hare Lagoon. During Scammon's time, the greys numbered at best 25 000, plummeting to only a few hundred whales at their low point. In 1937 an international conservation programme called for a moratorium on grey whale hunting. Their continued existence was assured, at least on paper, when the 15-nation International Whaling Commission recommended that the prohibition on killing grey whales remain in effect indefinitely. The US has banned imports of all grey whale products. This protection has been responsible for the resurgence of the California grey whales and of California's annual cetacean show.

Due to their regular migration down the California coast, the grey whales are the best studied of all the marine giants. Yet the leviathan remains as mysterious to modern oceanographers as it did to Herman Melville, the author of *Moby Dick*. For example, debate still continues over whether the greys feed still continues over their more than 8000 mile round trip between the Arctic and the tropics. Whales are known to breach, that is raise the upper part of their bodies out of the water, and no one seems to know why they do it. Speculation includes: looking around at objects on the surface; abruptly changing direction to avoid a collision course with a mammoth object such as a pier; courtship behaviour; attempting, via water friction, to remove some of the numerous barnacles that have attached themselves to the whale's skin; and allowing a mouthful of food to migrate under the influence of gravity from the whale's gigantic mouth to its gigantic four-chambered stomach. Another interesting habit is that mating is done in threes—one female and two males. The role of the second male is not well understood but it has something to do with mutual assistance.

Whales are equipped with baleen filters, instead of biting and grinding teeth, to feed on small organisms. The giant tongue that directs the flow of food can weigh 300 lb. The mass of a full-grown adult can reach 35 tons on a 50-foot frame. A newborn calf can be as long as 17 feet. Thrusts from their powerful tail flukes propel the greys along during their migration at a comfortable cruising speed of four knots. In order to make a super breach, they can swim as fast as 30 knots—faster than most ships.

Generally the greys are rather docile. Despite the large number of sightseeing boats that have cruised around their flukes, very few whales have attacked. In those cases when a grey has charged,



it was usually provoked by a harpoon through its skin. As whaling harpooners are almost an extinct breed, the present-day harpoons are usually set by ocean scientists attempting to tag an animal or attach a tracking device. Convinced that one cannot study these wounded whales and expect them to represent the normal population, a University of California marine biologist and his colleagues have developed a new technique for tagging and tracking whales. Kenneth Norris of the Santa Cruz campus hopes to unravel some of the whales' well kept secrets by placing harnesses equipped with various sensors on several California grey whales.

Harnessing a whale, especially an adult one, is no easy matter. Norris and his co-workers circumvent that problem by harnessing baby whales in one of the shallow lagoons in Mexico. They separate a calf from its mother by roping it and bringing it into shallow water where the enraged female dares not go. Last year they successfully harnessed several calves for short periods before a special release mechanism freed the animal. This year the Santa Cruz team will travel to the breeding ground in Magdalena Bay with harnesses that expand as the baby whale grows. And they grow at a phenomenal rate—during the first year of life their length increases by about 60 per cent. The harness is made adjustable by a sliding mechanism with internal friction so great that it can only be overcome by the slow steady strain of the growing mammal.

If the harnesses are deployed successfully the whales will be tracked for three or four weeks during their return trip to the north pole area. Sensors will record data relating to their heart beat, stomach temperature and other internal organs. It will also record the adjacent aquatic environment giving information about the light intensity seen by the whales, the amount of time they spend submerged between breaths (present measurements give 8 to 15 minutes) and the pressures on their bodies during dives.

Norris's work will provide some new information about the largest marine mammals, but many mysteries will still remain. Even with our lack of understanding, the California grey whale migration is one of the greatest shows on earth. If you happen to be in the neighbourhood next January, be sure to take a look. *Gerald Wick*

Scientific finance

Discounted cash flow

Previous articles in this series have described how to prepare and implement a personal financial plan using modern management techniques. Similar techniques can be employed usefully in financial decision-making. Given a choice between £100 today and £100 in a year's time, most people would prefer the money now, for if it is not needed immediately it can be invested to produce more than £100 in a year's time. This is

an illustration of "the time value of money", ie the value of a sum of money depends upon the point in time when it is received or paid.

For daily affairs, the time dimension can usually be ignored. However, for large items of expenditure which involve a long period of time, neglect of the time value of money can result in considerable waste of resources. The technique used by organisations is discounted cash flow (DCF), which has become very popular in recent years although it has been known, if little used, for much longer. The same technique can be used in personal affairs, as it is mathematically relatively simple.

The process of discounting cash flows means finding the value at one point in time of money paid or received at another time. If £1 is invested at 5 per cent interest, it will be worth £1.05 in one year, £(1.05)²=£1.103 in two years, £(1.05)³=£1.158 in three years, and so on. If these factors are divided into the receipts/payments for the year to which they apply, this will reduce or "discount" the cash flow for that year down to its present value—at 5 per cent discount rate. In practice it is usual to express the factors as reciprocals (eg 1/(1.05)³=0.907) and then to multiply instead of dividing. Present Value Tables are available which give a range of discount rates for different time periods.

Suppose one has a three-year-old car which cost £900 new and is worth £500. Annual running costs average £200 to date and are estimated at £250 for the next three years, after which the car will

Case A: Keep present car; sell for £200 in 3 years

| Year | Present Value (£) of cash flow at discount rate: | | |
|-------------------|--------------------------------------------------|----------|----------|
| | 0 | 10 | 20 |
| | Per cent | Per cent | Per cent |
| 0 | — | — | — |
| 1 | 250 | 227 | 208 |
| 2 | 250 | 207 | 174 |
| 3 | 250 | 188 | 145 |
| | 750 | 622 | 527 |
| Less value of car | 200 | 150 | 116 |
| Net present value | 550 | 472 | 411 |

Case B: Buy new car at £900—500=£400; sell for £500 in 3 years

| Year | Present Value (£) of cash flow at discount rate: | | |
|-----------------------|--------------------------------------------------|----------|----------|
| | 0 | 10 | 20 |
| | Per cent | Per cent | Per cent |
| 0 | 400 | 400 | 400 |
| 1 | 200 | 182 | 167 |
| 2 | 200 | 165 | 139 |
| 3 | 200 | 150 | 116 |
| | 1000 | 897 | 822 |
| Less value of car | 500 | 376 | 289 |
| Net present value (B) | 500 | 521 | 533 |
| " " " (A) | 550 | 472 | 411 |
| B - A | -50 | +49 | +122 |

he worth £200. Should one buy a new car or keep the present car?

If the time value of money is ignored, £50 is saved over three years by adopting Case B. However, if one could earn 10 per cent interest on the money not spent on a new car, one would lose £49+50=£99 with Case B. Furthermore, if one had to pay 20 per cent to borrow the £400 for Case B, one would be £172 out of pocket.

There is of course no obligation to accept the lowest cost route. One might well consider it worth spending £99 or £172 to possess a more up-to-date car. If this is a deliberate decision, well and good, but much money can be wasted by making decisions in partial ignorance of the facts. One of the advantages of the DCF technique is that it forces one to look consciously at all the factors involved. Of course some of these factors cannot be estimated very accurately (eg the value of a second-hand car in three years' time) but it is better that the assumptions made are stated explicitly and that an effort is made to quantify them.

The perceptive reader may observe that no allowance has been made for depreciation. In profit and loss accounting—and sometimes in personal tax matters—one should make appropriate provision for depreciation. However this article deals with decision-making, where the prime determinant is cash rather than book values. In this context, depreciation is irrelevant.

The use of the DCF technique is not confined to decisions on spending; it is just as useful for comparing alternative sources of finance (eg savings, bank loans, hp contract) and is applied in similar fashion. Where the tax treatment differs between the different sources, all of the cash flows must be brought to a common basis, bearing in mind that a tax credit may be available at a different date from the original payment.

William Prentice

Turkish notebook

InshAllah technology

The new bridge built between the European and Asiatic sides of Istanbul is felt by many Turks to be symbolic of their country's close link with Europe. Not only is the Asiatic bank now visibly tied to Europe, but the engineering which went into its building is also felt to be indicative of Turkey's alignment with the West's technoculture. Despite the fact that the \$35 million bridge was built by a foreign consortium (headed by Freeman Fox and Partners) the Turks point to it with pride as evidence of their own burgeoning technological ability.

Yet, in Istanbul at least, on a less elevated level, the crumbling buildings, the ramshackle vehicles and the frequent dips and failures of the electricity supply indicate that technical competence is not spread thickly or evenly throughout Turkish life. I asked an engineer, a graduate of Bosphorus University, if there was anything evident in the Turkish character to account for the Levantine appearance of Istanbul's shoddy fabric.

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digital



"Yes," he said, "the Turk is a nomad, not a builder. He always expects to move on in a day or so, and cannot put his heart into building anything to last."

But how did he account for the splendid mosques, and particularly the minarets whose slender symmetry argues at least an intuitive understanding of civil engineering? "The mosques were built by Ottomans, not Turks," he said, a distinction that is difficult to define, and not necessarily acknowledged even in Turkey.

Perhaps his observation was coloured by his own intriguing background. He belongs to a formally unacknowledged group of Turks who are descendants of Shabbati Zvi's followers. Shabbati Zvi was a Jewish adventurer who, living near Smyrna (now Izmir) in the middle of the 17th century, declared himself to be the true Messiah. His followers (principally but not exclusively Jews) became so numerous that the reigning Sultan told him that unless he gave up his claims and embraced Mohammedanism he would be executed.

Zvi caved in, and he and his supporters underwent a mass conversion. Although they embraced the Moslem faith without any apparent deception, they and their followers retained a social autonomy, that even now is still in evidence (Zvi became the Sultan's doorman).

Not all the Sultans were equally wise. Abdul the damned, who reigned towards the end of the last century is said to have had a great fear of electricity because he confused the word "dynamo" with "dynamite". As a result the introduction of electricity into the country was delayed longer than its neighbours.

In one respect, Turkey was au courant in its time, in that an underground railway was built in Istanbul at the same time as the Paris Metro. It consisted of six cars, divided into two trains of three cars each. The trains were arranged to go in opposite directions, one uphill, the other down, and were connected by a cable that ran around a large pulley at the station at the higher level. Power was supplied by steam. Now, almost 100 years later, the system is more or less the same, except that it is driven by electricity. But there are still only two stations.

★ ★ ★

"Lightning" telephone calls between Ankara and Istanbul are subject to delays lasting 20 minutes; those in the "fast" category up to an hour; those in the "normal" category, according to one frustrated subscriber, are "slower than a letter, and less effective than shouting". For calls to Europe the delays are multiplied proportionately.

Turkey is suffering from a common malaise of developing countries—an uneven growth in its technology. In the telephone system, which was installed originally as part of Turkey's Westernisation programme more than 60 years ago, each subscriber's link to the exchange is taken through individual pairs of conductors that loop crazily from house to house like strings of long black bootlaces. The nearer a house is to the exchange the more numerous the conductors in the bundle, until, when a

hundred or so pairs threaten to pull down the wall on which they're fixed, the wires drop down a wooden pole usually covered with vines, and disappear underground.

Water, poor joints, and mechanical damage due to wind and high-spirited children seriously impair transmission quality and lead to a high incidence of faults. The arrangement of wires makes fault-finding a matter of luck rather than skill; one of the eight Canadian technicians who are installing Crossbar exchanges in an attempt to resuscitate the network, had a fault on his own telephone that took four days to find.

A story is told of the British occupation of Istanbul during the First World War, in which information about troop movements was constantly being transmitted over the telephone to Turkish troops in the field. The British were unable to plug the leak because, despite several weeks of work at the central exchange, they couldn't trace the pair of wires which led out of the town. The Turks insisted then that no wiring diagram existed and the present confusion would seem to suggest that the situation hasn't altered much.



A common aspect of Turkish daily life which adds to the telephone chaos is the frequency of the mains power failures. Like most telephone systems the network is powered by a dc supply rectified from the mains. When the power fails, a bank of lead-acid batteries takes over until an emergency diesel-driven generator is started. Unfortunately it is impossible to charge the batteries fully in the Turkish exchanges, because of their unusually high internal resistance (they are manufactured locally). This characteristic not only severely limits their useful discharge time but also causes a high voltage drop when they are loaded.

Local calls are not cheap by Turkish standards, but even so it seems that many subscribers' bills have been excessively high due to a peculiar fault on the automatic billing system. A representative of the Post Office, speaking on the radio, warned listeners not to tap the receiver, rest up and down in their attempts to gain the operator's attention (there is no direct dialling between cities) as each time the telephone was disconnected, a finished call was often recorded. Thus, even if a subscriber gives up trying to

establish a connection he might be subsequently charged for 10 or 12 calls.

A microwave link has been installed for NATO use by Northern Electric Telecommunication, the same company which is now modernising the existing network. It is alleged that VIP's and their elected favourites use this system for calls to the rest of Europe, although this is strenuously denied. However, radio correspondents of a number of European countries recently found that good quality voice transmission became possible for the first time recently after a massive protest to the Turkish Press Office. Perhaps it was just a divine coincidence: "InshAllah," as the Turks say—"it's in God's hands." *Fabian Acker*

Tinker's travels Up the jungle

Being a Briton abroad comes tedious these days, for the world's press is full of smug articles about England's coal crisis, toilet-paper crisis and oil crisis. Especially the oil crisis. "Dropping in to fill your hip flasks, are you then?" inquired the cab driver genially as he drove me to the Petroperu offices in Lima, as soon as he knew I was British. It was, therefore, with a certain sense of relief that I arrived in the Manu National Park in Amazonia, which is still largely inhabited by Amerindian tribes which have never been in contact with the white man. Here at least people would not be raving on about petrol all the time.

Alas for my illusions. An American petrol company holds an exploration concession for part of the park, and all the Forestry Department can do is hope that the search is unsuccessful. If the present seismic survey proves positive, drilling will certainly follow. "If we find oil anywhere in Peru," said the general in charge of exploration recently, "we shall extract it even if it involves drilling in the grounds of the President's palace". On that basis, a remote national park is hardly likely to receive much protection.

If oil looms over the Manu's future like a dark cloud, inside the park petrol is the small change of everyday conversation. Apart from the oilmen, who flit around in orange helicopters, every one in the rain forest travels by canoe. Some of the Indians still use only paddles, but the park guards and those tribes with at least some regular contact with the white man rely on outboards. Owing to the somewhat bureaucratic nature of the Peruvian national park administration, all funds are allocated to the Manu from Lima, 400 miles and 6 days away. Petrol for the outboards has to be indentured for in Lima and purchased in Cusco, before being trucked over the Andes in 20-gallon drums and then carried four days by boat. This process is somewhat spasmodic, and as I visited the park immediately before the next batch of petrol arrived, the guards were extremely short of juice. Every journey was preceded by lengthy discussions estimating the petrol likely to be needed.

A miscalculation marooned me for 24 hours at one camp with nothing but one papaya to eat, and had the first boat supply for three months not arrived fortuitously, I would have been there for a week.

My first night was spent at Pachija, where a new guard post is being constructed on the edge of the park. There the guards monitor all boats using the Rio Manu, and the poaching of spotted cat and other skins, which four years ago was common, has virtually stopped now. Pachija is a new station, currently being constructed to replace the old post a few miles upstream at Panagua, which had to be abandoned because it flooded regularly. The site was chosen some years ago, apparently after only a few days' investigation, by a foreign conservationist who was dispensing several thousand dollars of European and North American wildlife funds. The money spent on Panagua over the years has thus been largely wasted, one of the occupational risks of using expatriate advisers who know little of local conditions. On the other hand, so few indigenous scientists in Peru and other developing countries are prepared to involve themselves in conservation fieldwork that foreigners, however ignorant, often have to take decisions of this sort.

Further into the park is the research station of Coche Cashu, idyllically placed on a horseshoe lake half a kilometre from the main river. From its verandah I watched alligators and turtles; aningas, those curious cormorant-like birds with necks like snakes; curassows, tree-living birds the size of turkeys; toucans, resplendent with everything except a glass of Guinness; and some irritatingly unidentifiable ducks which I think were wild muscovies, the ancestors of those to be seen in any English farmyard.

Chugging up river in an outboard-powered dugout canoe is not the best way of seeing shy wildlife, especially in the wet season when the sandbanks are not exposed. The most obvious birds are the parrots, which range from enormous yellow-and-blue macaws two feet long to little green parakeets the size of a sparrow. They are all extremely noisy, and highly gregarious. The Manu's second guard post stands 200 feet above the river on a high bluff, so that one can look down on the birds in the trees on the opposite bank. There I watched an endless series of large birds fly past, many of them pausing to perch in the few tall, isolated trees left standing on the acre of cleared ground around the post. Woodpeckers, curassows, parrots, toucans, orioles: the colours and shapes are all slightly unreal, as if the tropical house at the zoo had been released into Regent's Park.

The guards at Tayakome have, inevitably, a close relationship with the nearby village of the Machiguenga, for the latter obligingly supply the park officials with a daily ration of two or three plucked macaws for the pot. The Indians are partially exempt from the strict park laws, being allowed to hunt wildlife by traditional means for their own consumption. They are not permitted to use firearms, nor are they allowed to sell skins

or other products. This rule is not entirely followed, partly due to the influence of a certain mission station. The father is said by the Indians to visit them regularly, supplying them with ammunition in return for skins and meat. As the missionaries have better communications in the jungle than the government, this is hard to stamp out. A couple of years ago, two French explorers were mysteriously killed by the Machiguenga within the park boundaries, and there are many other tribes some of them head hunters—which lack even the minimal contact these people have with the outside world. Administering the Manu, therefore, is rather more complex than wardening Snowdonia.

Jon Tinker

Out and about

The rest is silence . . .

One almost incomparable and, to a certain extent, compensatory gift I have received in latter years is the opportunity to walk regularly for miles and miles amid something very close to silence. Up here on the springy crests of the North Riding moors you can tramp, as I did this morning, for three hours without hearing anything more mechanically disturbing than a tractor far down in an adjacent dale, an event less traumatic by far than the explosive cackle of a disturbed grouse gritting in the bed of a beck. Of birdsong of more endearing kind, pipets seem to peep almost everywhere at almost any time. Curlew, green, grey and golden plover are something to be looked forward to a little later on, on the high tops. Down in the valley, where the ling and bilberry meet the gorse and the uppermost trees, usually rowan and holly, the robin sings throughout the year, with the possible exception of July; the song thrush starts up again in December, the mistle thrush in January, the blackbird in February and the ring-ouzel in March and April, together with the first of the other early immigrants.

Curious how birds within that same genus, *Turdus*, begin to sing at different times. The timing, no doubt, is conditioned by their different territorial needs and as a preliminary to pair-bonding. As Edward Armitage puts it nicely in that little classic of his on the subject: "The birds have grown to know each other individually and their sexual cycles have become synchronised so that the songs and posturings which in many species precede copulation are omitted".

Among birds that are easy to sex on sight, even in flight, such as chaffinches and bullfinches, it is now a matter of fairly common observation that, on occasions, the females will sing, although not so long ago this notion was pooh-poohed by some uptight ornithologists. To those few avian equivalents of the whistling woman I would add the ring-ouzel or white-collared blackbird. In places where the bracken flanks our scrubby pastures at a height of near a thousand feet it is not uncommon to see ouzels and ordinary blackbirds within a few yards of

each other and, to judge from their alarm calls (which are not unlike), they were somewhat uneasy about each other's presence.

In such a place last year I both saw and heard the song of a female ouzel; unless, of course, it was a male with a very dirty collar I was looking at. She croaked away in a cracked voice. A blackbird sang vociferously nearby but what his song meant I cannot say. The mate of such a bird may become confused by such behaviour and attack her. One such female, a chaffinch, stopped singing after laying her third egg and started again in a desultory way when the nest was robbed. At this the cock undertook major responsibilities for feeding and generally looking after the young, but the lives of the chicks were in jeopardy as he spent much of his time chivvying his mate back to her duties. The sound of pairs of duetting wood rails have been likened to "an aged couple singing in a shaky, quavering voice a song of their youth".

But to get back to that silence—which is what I started to write about—it is not until you wander deep in the country where the ears and not the eyes have it, that you realise that, with the thunder of cities and echoing walls, the Muzak of eating places, the Festival Hall effect and the current obsession with stereo speakers, few of us are conscious of a sound's direction. We live, most of us, in a new form of auditory acoustic space whose centre is everywhere and whose margins are nowhere. Try your ears out sometime during a cold still January evening where the only sound is that ringing contralto of a distant mistle thrush and you may agree that we are losing something else.

John Hillyard

Tantalizer

No 332 Think of a number

"Write down a number of four different digits."

"I've done that."

"Subtract 1111 from it without borrowing and write the result down under the first number. Do this four times more."

"How do you mean 'without borrowing'?"

"I mean that if you started with 1023, for instance, the second number would be 0912, the third 9801, the fourth 8790, the fifth 7689 and the last 6578."

"Right. I now have a list of six numbers."

"Add them up and what do you get?"

"41349."

"Then the number you first thought of was . . ."

What?

Martin Hollis

Solution to Tantalizer No 331

Sunt lacrimae rerum

25 August

In n days they consume $n + 9n/8 + 9n/10 = 121n/40$ of what the Warden would consume on his own. So $121n/40 = 3n + 1$, solving for $n = 40$. So the Warden expected the port to last 121 days.

Feedback

Engineering design trouble-shooters

British engineering firms are notoriously reluctant to farm out design problems when these are beyond the competence of their own staffs. The Design Council, whose terms of reference have recently been changed to place more emphasis on engineering aspects, is attempting to introduce a new approach. Geoffrey Constable, head of the council's engineering design section, is embarking on a series of measures to this end.

The main problem seems to be that, although a great deal of expertise is available, there is no middleman systematically employed in connecting individual know-how. Constable is setting up a group of people to fill this role—the field officers of engineering. Their job will be to visit individual companies and help them identify their problems. They will not attempt to advise but will suggest a specialist that would provide the answer. An experiment to see how useful such field officers might be, has been encouraging. About a third of the factories visited had troublesome problems. In all cases they willingly accepted advice from the experts eventually nominated.

The council is now collating a Directory of Design expertise which, incidentally, will include many experts, recently retired, whose know-how is often shamefully wasted. A series of design guides is also envisaged—the first on fastening systems, is to be published shortly by Oxford University Press.

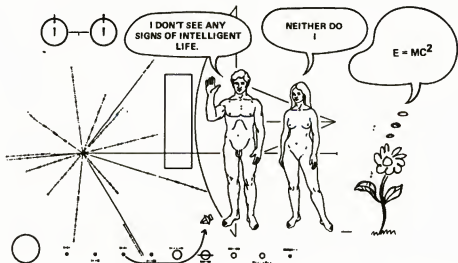
Design awards for engineering products, which have been available for some time, will now be greatly expanded and serve as still another pathway through which to filter design know-how; for the companies who submit products but fail to win an award will not only be told the comments of the judges but will be visited so that the defects of their design can be explained to them in detail.

Weinberg's new job

Dr Alvin Weinberg, one of the world's leading experts on nuclear energy, went to a new job barely a week after he retired from directing the Oak Ridge National Laboratory. He has been appointed director of R & D policy under the new federal energy administrator, William Simon.

When he retired from Oak Ridge Weinberg said he wanted to set up a small think tank to be called the Institute of Energy Analysis. This project will still go ahead even though its founder will be on leave of absence for as long as the government needs him.

A passionate advocate of nuclear power, Weinberg should play a major role in coordinating R & D strategies and advice which Science (vol 183, p 288) says



This cartoon, based on the celebrated Pioneer 10 plaque, won James Paul, a graduate student of the University of Michigan, the \$1000 prize in a competition organised by TRW Inc. There were more than 7000 entries

has "emanated from all over the Executive branch" till now. Weinberg expects this group—in the event of Congress formally sanctioning the creation of a Federal Energy Administration—to remain in the White House executive to form the nucleus of a new advisory staff to President Nixon.

Help to promote self-help

The Intermediate Technology Development Group is eight years old. Its director of development, Mr George McRobie, recently described its progress in a lecture to the Royal Society of Arts in London. In cooperation with national research institutions, business firms, universities and technical colleges both in Britain and overseas, it has been working on a range of activities essential for rural development in the Third World. Its field officers working in Zambia and Nigeria have already been helping in the local manufacture of machines for grading and shelling ground nuts, weeders, cheap equipment for blacksmiths, and better oxcarts. There is a unit in the National College of Agricultural Engineering at Silsoe, Bedfordshire which, among its other contributions, has designed and produced a hand-operated multipurpose machine for bending metal, at a cost of £7 (against the cheapest available commercial machine's £750). Building teams are at work in various countries helping to improve efficiency, and the group has published a practical handbook based on African experience. The industrial liaison unit has developed a paper-pulp packaging machine suitable for small markets, costing about a twentieth of the only machine formerly available. The food technology team has carried out field work in Tanzania in the development of maize/bean mixtures suitable for wean-

ing foods. The power panel is working on a pistonless water pump operable by a variety of fuels. Cooperatives are encouraged. The group is keeping a friendly eye on a building and housing cooperative at Tema in Ghana.

As Mr McRobie pointed out, the group has depended largely upon voluntary and charitable subscriptions to support its activities. Not the least attractive of its features is its emphasis (as McRobie put it) "on giving people in poor countries the opportunity and the means to work themselves out of poverty."

Rising costs of immortality

The bizarre technology of freezing corpses in the hope that they may one day be brought back to life achieved some notoriety during the 1960s. In recent years, for a variety of reasons, interest has been falling away. In Los Angeles last week, Mr Robert Nelson, president of the California Cryonics Society, revealed that the number of inquiries received by the society had markedly declined. Rising costs of preserving the corpses is one reason for the decline of interest. Two bodies—to be followed possibly by a third, that of Dr Robert Bedford, the first to be treated by the process—have been withdrawn from the deep freeze because the families concerned have lost interest in the project. At present 14 bodies are stored in rented space in Los Angeles and New Jersey. It takes \$300 a year to maintain (through liquid oxygen) the required temperature of -320 degrees Fahrenheit. The total cost of cryonic "suspension" is in the region of \$20 000 including the cost of a stainless steel cylinder. In an effort to control rising costs the California society is experimenting with larger—communal—cylinders.

To eat or not to eat



It is reassuring that the oil crisis, money crisis, resource crisis, not to mention the crisis crisis, is not stifling truly creative research. McDonalds, the American hamburger chain that straddles the highways, has just announced that it is completing a daring five-year \$50 million research programme. No expense, no expertise has been spared. The object of all this effort is to develop a wholly palatable fried chicken. McDonalds prides itself on the complete uniformity of its hamburgers. Wherever the place you may eat in may be, the McDonalds hamburger is the same. Fried chicken has so far, it seems, been reluctant to accept such discipline. McDonalds executives—and the firm runs a McDonalds University which presumably offers courses in such matters—have been frightened of introducing fried chicken on their menu until they were sure the product would not vary in both taste and texture. McDonalds, of course, wants people to eat as much as they possibly can. But while McDonalds tempts your palate, many Americans are worried about their weight. On Professor B. F.

Skinner's floor at Harvard, there is a letter posted from a weight-losing organisation. Impressed by operant conditioning, they want some bright new graduate, fresh with all the latest behaviour modification techniques, to "shape" them into the right shape.

At the Mount Sinai hospital in New York, more emphasis on losing weight. Doctors there have come up with an ingenious technique to help those who obsessively over-eat. It has nothing to do with calories or carbohydrates. To start your diet, you just need paper and pencil! Every day, you write down what you have eaten. Every morsel of food is followed by your cataloguing it. This has a number of beneficial effects. First, people are appalled by how much they have eaten. There is usually a tendency for people to fool themselves. ("I'm not really eating that much," you say as you gobble your fifth hunk of bread and jam at tea). Second, people know that when they eat they will have to write it down. This intensifies guilt over eating. Third, as you eat less, you have an accurate chart of it. This keeps your morale up. And this, in Skinner's terms if you like, rewards you for eating less. Science is still making strides.

A crush on chemistry?

To coin a phrase: some people are born to be chemists, some achieve chemical qualifications and others have chemistry thrust upon them. And if the 150 London

Fatal navigation

"There were some 80 million people in three theocratic agricultural civilisations based on irrigation: The Aztecs in Mexico, the Mayas in Central America, and the Incas in Peru. A century and a half later, only three million of their descendants remained. The others were exterminated. For these people, navigation was more terrifying than the bomb at Hiroshima."

Dr Oscar J. Maggiolo Campos, former director of the University of Montevideo in a paper to a UNESCO symposium on the human applications of Scientific advance

area sixth formers who attended the one-day event on "Why Learn Chemistry?" run by the Chemical Society don't now know what category they belong to, this is no fault of the organisers.

The case for chemistry was put by Malcolm Frazer who holds the chair of chemical education at the University of East Anglia. After lunch, smaller groups of youngsters heard more evidence and posed questions to recent chemistry graduates now working in research, education, industry and local government.

Judging from the predominantly female audience, chemistry departments will be overwhelmed with women next year; or was it that the men had made their minds up already?

The last word on . . .

Operatic medicine

Ever since Asclepius, it has been a basic tenet of medical science that the number of folk cures proclaimed for any human ailment is in direct proportion to the ignorance of professional doctors about its possible cure. As evidenced by the high incidence of bald-headed men and the fact that every animal, vegetable or mineral mush which is amenable to massaging into the scalp has been hailed at some time or another as the ultimate pabulum which will grow hair on naked, masculine pates. And by the manner in which, as the common cold continues to defy every assault of medical research, the recommendations proliferate from lay sufferers for its only, true cure. And since this is the high season for blocked noses, sore throats and stentorian sneezes, it may be helpful to the currently afflicted to learn that there is lately some happy conjunction as to sovereign remedies between operatic and hippocratic practitioners. Both prima donnas and their leading tenors depend for their high living and continued careers on being able to overcome attacks by the determined tarpeia perennans virus and their advice should be respected about how best to deflect or overcome its visitations.

From Hamburg has come news of the various personal plays adopted by German opera singers to protect their professional voices from being reduced

to husky croaks by the common cold. Hans Beier, the Berlin tenor, discloses his spartan prophylactic that "Before every performance I stand under a shower as hot as I can bear it with my feet in ice-cold water". It is not immediately easy to see how he keeps the pedal water at icy temperature, but Herr Beier certainly has some scientific support for his method from medical researchers at Haifa's Rothschild Hospital and Institute of Technology, from which it has earlier been reported that the symptoms of the common cold would disappear if the temperature of the sufferer's feet was rapidly lowered to -5° Centigrade. Anyone desperate enough with the raging sniffles to test this combination of water cures might try sitting in the kitchen sink with his feet in the fridge while his wife pours kettles of hot water over his upper structure.

The soprano, Julia Varaday, of the Bavaria State Opera, recommends a more genial course of treatment which merely relies on the internal application of a glass of slivovitz—Hungarian plum brandy—three times a day. Such regular consumption of this fruit-based liqueur with its Vitamin C content might well find support from Nobel Prize winner, Dr Linus Pauling, who has advised the regular consumption of massive doses of that vitamin as the sovereign repellent of the common cold. Another member of

the Bavarian company, Erika Koeth, has a line of hygienic defence even more in keeping with the latest scientific theory. To avoid any attacks of the sniffles, she says, "I refuse on principle to shake hands when there is an R in the month, and before going to bed I run iodine into my hands and inhale it." This avoidance of digital contact would find applause from the University of Virginia School of Medicine where researchers have pronounced that humans are more likely to catch cold from shaking hands than from kissing. On the grounds that the rhinovirus, which is responsible for one third of all sneezing, prefers the palm of the hand as its external home to any other part of the body. It is only to be hoped, on behalf of the male members of her company, that Fraulein Erika, in following the Virginian edict to eschew hand-shaking, is replacing that salute by lots of wholesome, non-infectious kissing.

But, for the greatest voice of them all, baritone Dietrich Fischer-Dieskau, there is little scientific support for his personal remedy to defeat the common cold. While seated with his feet in a hot mustard bath, he swigs head-lightening glasses of rum grog. Which prescription, though not specifically recommended by any learned medical authority, has the proven advantage that, whether or not the potion of hot alcohol does anything for the operatic voice, it certainly makes the symptoms of the cold more pleasantly bearable.

Patrick Ryan

Letters

Metazoan life

Sir,—Facts in geology are notoriously subject to change. It is not many years since it was generally accepted that there were no animal fossils preceding the Cambrian. There have now been substantial finds of pre-Cambrian metazoan fossils particularly in Australia, south-west Africa and Russia and there are good reasons to expect that similar finds will be made in eastern California. Dr Steven Stanley's "fact" ("Cropping and the Cambrian explosion," 17 January, p 131) that animals with mineralised skeletons appeared at the same time as other evidence of metazoan life cannot be upheld. In Australia the first shelled animals are separated by at least 2000 metres of sediment from the oldest known undoubted track; probably of a mollusc. The rocks yielding the diverse and essentially soft-bodied fauna at Ediacara (South Australia) are separated from the overlying Cambrian (with calcareous fossils) by up to 500 metres of sediment.

In spite of the diversity of the algal flora in rocks 900 million years old, seemingly biologically poised for metazoan breakthrough, it was another 300 million years before metazoans appeared. It is not so easy to ignore, as Dr Stanley has done, the importance of the build-up of free oxygen during this period. It seems that an oxygen level equivalent to 10 per cent present atmospheric level is necessary for the retention of a calcified skeleton. The soft bodied fauna at Ediacara is preserved in sandy sediment of a type which, today, is normally sufficiently oxygenated to prevent fossilisation. The deficiency of oxygen during the Cryptozoic Pause suggests that the cropping principle only became effective as

oxygen accumulated and metazoans gradually diversified.

Roland Goldring

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Reading RG6 2AB

Leaf nuclei

Sir,—Seeing your reference to leaf-derived nuclei (Monitor, 29 November, p 606), I am prompted to ask if the tiny particles of essential oils, given off by trees such as eucalyptus and pine, may not have the same effect. The eucalyptus, in particular, evolved in arid conditions, in which artificial cloud seeding would have had considerable survival value. The blue haze hanging over eucalyptus forests in Australia is well known. Moreover, the trees appear to intensify their output in thundery weather. It does not seem likely that this vigorous chemical activity by the trees is fortuitous. What other reason for it might one postulate?

R. C. Denning

PO Box 628
Lilongwe, Malawi

Demolition code

Sir,—Mr Peter Campbell and Mr Wilem Frischmann (27 December, "Demolition problems for our children," p 907, and "Register could prevent hidden traps," p 908) make very pertinent points which were considered by the committee which prepared the British Standards Code of Practice on Demolition.

On the question of the demolition of prestressed concrete structures, the code emphasises that the advice of a chartered engineer should be obtained and specif-

cally advises that information on the structural design and method of construction should be obtained. Ideally, of course, detailed records of the design of the structure of every building should be kept in a known place for reference when alterations to the building become necessary or when demolition is contemplated. However, the committee felt that the Code of Practice on Demolition was not the place to recommend this as this code presumably will not be used until the time of demolition comes. The place for such a requirement should be in the local by-laws.

The last paragraph of the code refers to special structures which would include structures subject to radio-active contamination. Specific mention was not made as the committee felt that it would be dangerous to mention any specific cases of special structures as this might lead to readers of the code thinking that these were the only special cases to be considered. It was obviously impossible to list every type of special structure and so we concluded by reminding the reader that where he met a special structure it should be treated on its merits. In the case of a building contaminated by radio-activity, one would also imagine that views other than those of engineers and demolition contractors would be heard.

Robert A. Hartland

Sir Frederick Snow & Partners
Ross House
144 Southwark Street
London SE1 0SZ

Manure cooker

Sir,—In response to G. Corbell's letter (13 December, p 802) on his pig manure cooker, although the apparatus described

Grimbledon Down

Bill Tidy



fulfils all the immediately apparent requirements it needs certain refinements before it can work. First, the equipment provides no motive pressure to force the gas from the generating cylinder to the burner, the result of this is that when the concentration of methane at the burner becomes high enough to ignite it will light back to the generator, combusting all the generated gas at an instant.

Second, the use of manure as a solid will hinder the evolution of methane. More success would be gained using a slurry of pigs' manure diluted with water (might be worth investigating algae-infested waters). Some form of stirrer would aid the release of methane from the slurry, if your aim is to use entirely "free" energy this could be wind driven.

Stuart Raymond

New Romney
Kent

Gould's award

Sir,—Dr Donald Gould has not survived 1973 "unhonoured and unsung" as he supposes (A groundling's notebook, 10 January, p. 85).

Each year the Anti-Science Society bestows an award upon the individual who has done most to hold science up to universal distrust, dis-esteem and derision. This year, I am pleased to report, after spirited controversy, the ASS award was given to Dr Gould. Though it was generally agreed that runners-up, Professor Steven Rose and Professor H. J. Eysenck had provided the public with more spectacular evidence of the overall vapidity, triviality, and subjectivity of science, in the end the society felt bound to honour Dr Gould's persistent, week-by-week undermining of the scientific image.

Dr Gould has never championed the hydrogen bomb, as did ASS award-winner, Dr Teller. Nor has he made great scientific statements such as: "Science is a very great work, perhaps the greatest of all the works of man," the utterance of which, alone, was enough to secure its author, Sir Peter Medawar, the ASS award. But by setting himself up as the Everyman of science, by providing a standard of unwavering Babbittism, insensitivity, banal atheism, and plain bad prose, Dr Gould has enabled countless lay-readers to see science as it really is. And this, in the eyes of the society, weighs heavier than any specific new weapon, means of torture, indignity to animals, evolutionary subterfuge or other significant advance.

This year, as in all others, the prize consists of a recording of Beethoven's Quartet in C-Sharp Minor and an all-expenses-paid trip to the Cathedral of Chartres. The Society trusts that, like all other award winners, Dr Gould will decline to accept.

Imre Karakal

Garrag Fawr
Porthyrhyd
Llanvorda
Carmar

Abortion figures

Sir,—Replying to Mrs Madeleine Simms (Letters, 24 January, p. 221), my criticism of the figures she was using is not that they are not official, but that they were incomplete, and therefore misleading.

This point, among others, is dealt with at greater length in my article on "The Abortion Act and all that" (22 November, p. 559), to which anyone interested should refer.

C. B. Goodhart

Gonville and Caius College
Cambridge

Genetic fix

Sir,—I should like to take issue with Dr Amital Etzioni ("Genetic fix," 17 January, p. 139) when he says "only carrots and frogs have been asexually reproduced, ie genetically copied". On the contrary, as every gardener knows, it is the easiest thing in the world to propagate exact copies of plants such as strawberries, roses, apples, pears, plums, cherries, potatoes, Jerusalem artichokes and a whole host of herbaceous border plants. If, however, Dr Etzioni meant to imply the process of cloning in the laboratory had only produced limited results, he is again wrong. The well-known techniques of callus and meristem cultures have made it possible to clone a large range of plant materials, such as orchids, chrysanthemums, vines, tobacco, carnations, freesias, to mention only a few.

These techniques are so well advanced that they are now being used on a considerable commercial scale in various parts of the world. The fact, therefore, that little cloning has been possible with animals should not blind us to the fact that in plants it is well-known and very widespread.

J. G. Hawkes

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Fade Out Theatre

Sir,—I would like to thank Mr Townson for his interesting suggestion regarding the origin of the Fade Out Theatre (Letters, 24 January, p. 221). He might be interested to know that there is some speculation that the Theatre in turn inspired another medical technique which has recently attracted some interest in South Africa. I refer of course to the treatment of ladies nearing parturition with a zone of reduced pressure around their abdominal regions. It is tempting to ponder on the possibility that some of the brilliant minds of the second half of the 19th century had mothers fond of vacuous entertainment.

I'm afraid my suspicious old mind detected a note of levity in the latter part of Mr Hock's correspondence (Letters, 24 January, p. 221). While his frivolities may have amused some of your

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readers, I cannot help feeling that the columns of a serious scientific journal are not the place for letters like this one.

Irvine Friml

14 Alpine Gardens
Bath
Somerset

Australian policy

Sir,—In these grievous times, we are all aware that government policy is one of the less stable determinants of the future. The Australian government is no exception. In the considerable time-lag between writing and publication of my article ("Down under science policy," 17 December, p 140) the glow of idealism has been somewhat tempered by the realities of government.

The proposed Parliamentary Committee on Science and Technology has been abandoned, perhaps largely due to the demand on time by the large number of committees already established. The concept of the Science Council also appears to have gone into limbo. Perhaps the present review of Australian science policy by the OECD will provide the necessary stimulus for action.

Ron Johnston

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Orienting churches

Sir,—With reference to Sidney Searle's article on old churches ("The Church points the way," 3 January, p 10) as a resident of Old Basing I would like to bring to his notice that the original part of the church was built in 1089 not 1200 as stated in his article.

1089 gives a deviation of 14°E from his graph, so if the church were built in that year, it was correctly oriented.

Alice Oliver

4, Church Lane
Old Basing
Basingstoke
Hants, RG24 0DJ

Sir,—The theory that the differing orientations of different buildings and parts of buildings built at different times are due to magnetic variation was first postulated by H. Wehner in 1906. His opinion was that the ancient Freemasons possessed a knowledge of the polarity of the magnetic needle, and kept it secret. It is good to see this use of magnetic orientation studied scientifically.

Orientation was first openly defied in 1584, when Sir Walter Mildmay, Chancellor of the Exchequer and puritan, founded Emmanuel College in Cambridge. He took over the remains of a Dominican priory dissolved in 1538, and converted the orientated chapel into the Hall, and the Hall, aligned north-south, as was usual, into the Chapel. When Sir Christopher Wren built the new chapel at Emmanuel, it was orientated, about 50 degrees north of true east.

In China until the revolution, and even

now on Taiwan, the art of Feng-Shui was carried out by geomancers, who used a special compass. Feng-Shui is akin to the western art of geomancy, where the "correct" sites for sacred and secular buildings were determined according to a system of proportion and geometry. This standard layout can be seen in the ground plans of monasteries and whole mediaeval cities, as shown by Chichester's aligned streets. Oxford and pre-war Bristol had other examples of aligned streets and churches. By analogy with China, a specific type of compass may have existed. A Chinese geomancer's compass is on display at the Science Museum in London, and was recently illustrated in a reprint of the 19th century book, *Feng-Shui, or the Rudiments of Natural Science in China*, by the Reverend E. J. Eitel.

Nigel Pennick

113 Shelford Road
Trumpington
Cambridgeshire CB2 2NH

Sir,—I was interested in the view of Anthony Whitty and E. A. Baker (Letters, 17 January) that churches were oriented on the point of sunrise on the day of the patron saint to whom they were to be dedicated.

In southern England the azimuth of sunrise on 22 June is approximately 50°, so that the total arc upon which to orient a church is 80°, and greater than this, of course, in the north. Therefore, if there are enough saints to go round, so to speak, we could expect churches in the south to be oriented up to 40° each side of true east. But I found values overwhelmingly much smaller than this.

Also it will be noted in Table 1 of my article (3 January 1974, p 10) that St Mary predominates, and the orientation of churches so named ranges from 15° south of east to almost due east.

Sidney Searle

Tidenways
Bosham
Chichester
Sussex PO18 8JC

McCormack's progress

Sir,—Somewhere in the English language there must be a word that means "Self-inflicted roadblock", but it escapes me for the present. However, it must be the only kind of roadblock applying to Mike McCormack's advancement as a scientist. The implication in Graham Chedd's article, "Man of energy" (6 December, p 709) that his "bosses" in the laboratories created roadblocks is an unwarranted reflection on their professional integrity.

The laboratories in which Mike worked from 1956 to 1970 had well-considered measurements of ability and performance on which to base advancement decisions. While some elements were necessarily subjective, the measurement task for applied science, the principal work of the laboratories, was not so difficult as it is for basic research.

It is not to be expected that a scientist of average competence, who simultaneously attempted a major career in the

political process, would advance as rapidly as peers devoting their whole time to laboratory affairs. To cast the situation in a British scenario, Mike's achievement was equivalent to serving adequately at the UKAEA establishment at Harwell while minding his local political p's and q's, and attending all legislative sessions in County Durham or Cumberland. That is the approximate geographical spread between the Hanford Laboratories and Olympia, Washington, the seat of state government where Mike McCormack served so effectively.

I offer these comments as the former manager of the Hanford Laboratories, 1956-65.

H. M. Parker

HMP Associates Inc
Richland
Washington 99352

Useful waste

Sir,—I am becoming increasingly disturbed by the quality and amount of reusable raw materials that are present in the garbage of this country. Why has no one set up, as in America, centres where one can discard of "useful waste", such as newsprint and metal food containers to enable it to be recycled? Better still why not set up separate refuse collection services for recyclable waste?

Maybe, we have to wait until we're in the midst of a world shortage before the government considers such proposals as with the present oil crisis.

G. N. Patrick

Flat 10
Furness College
Lancaster University
Bailrigg
Lancaster

Supermarkets

Sir,—Ron Brown's "Trouble at the checkout point" (13 December, p 766) was a good illustration of how big supermarkets (together with other big companies) look to "advanced technology" to solve today's self imposed problems of size. My guess is that with fuel costs rising steeply, increased checkout throughput will do little to offset rising costs in other areas of supermarket operation. It will certainly increase labour turnover and customer distrust, if shoppers are to be shunted like cattle trucks into sidings to bag their goods, while the bill is put in "memory" for the inevitable incorrect recall.

The next real advance, let's face it, is to give our shopping list to the local shop who then deliver by bike. This process does away with the whole denigrating process of food shopping. And if the local shop buys and distributes locally, think of all that expensive oil we'll be saving (with less packing too). This looks like a case for Technology Assessment. Will supermarkets survive the future?

Mike West

6 Hillbrow Close
Rowlands Castle
Hants

Review

Case for 'counterfoil research'

by Dr Martin Sherwood

Energy and equity

by Ivan D. Illich
Calder & Boyars, pp 96, 60p

The tendency to confuse process with substance (which, according to Illich, is the result of schooling), leads us to believe that progress is "a good thing". Once progress has been reified, it becomes difficult to see around it. If one accepts Illich's contention that, in a progress-oriented society, expectations always exceed achievements, then we are gradually building ourselves into a sepulchre compounded of our own delusions. The process is aggravated by the fact that most political parties accept the underlying assumption that progress is a good thing; consequently, politics is unlikely to help us escape from the consequences of foolishness.

Illich sees a partial answer in "counterfoil research"—research aimed at questioning the assumptions on which society operates, in concrete terms. Such research can be seen as a forerunner to cultural revolution which (in Celebration of Awareness) he defined as "a review of the reality of man and a redefinition of the world in terms which support this reality". The possibility of such counterfoil research was discussed in the methodologically-biased *Tools for Conviviality*, published last year (see Review, New Scientist, vol 60, p 288). In *Energy and Equity*, we have a first draft of a counterfoil inquiry into traffic (which, in Illich's definition, is "the movement of people from one place to another when they are outside their homes", and which is made up of transit—"those movements that put human metabolic energy to use"—and transport—"that mode of movement which relies on other sources of energy").

The book has been published in a draft form, on which readers are invited to

comment; it is stated that the author's ideas are still developing. Certainly, there is an occasional roughness in the style of argument that does not occur in Illich's earlier books, and the occasional remark which appears nonsensical ("Once some public utility went faster than ± 15 mph, equity declined"; how does anything travel at -15 mph?). However, on the whole, the same compelling aphoristic style is used, with the same stunning effect.

The initial chapter deals with "the energy crisis" in summary terms: "It has recently become fashionable to insist on an impending energy crisis. This euphemistic term conceals a contradiction and consecrates an illusion." Man measures his wellbeing by the number of "energy slaves" at his disposal: "The energy crisis focuses concern on the scarcity of fodder for these slaves. I prefer to ask whether free men need them."

The problems of the growth of transport at the expense of traffic are, according to Illich, the growth of inequality between men, restriction of mobility to a system of industrially defined routes, and the creation of time scarcity. The reification of time within an industrial society is one of Illich's continuing preoccupations. We have turned time into a commodity: "time is money".

He shows, with conviction, that the increased speed of transportation for the few is achieved only by "net transfer of lifetime". For the convenience of the few, designated as "important people", the remainder suffer through restrictions on their own mobility that require greater consumption of their own time than if they relied on metabolic power—either walking or bicycling. Consequently, even in our own terms, ever-faster transportation systems can be seen as aids to theft: they permit the few to steal the time of the many. But people do not go to

jail for the theft of other people's time; they acquire social status—the remainder of us are kept from revolt by the prospect of becoming time-bandits ourselves. "Tell me how fast you go," says Illich, "and I'll tell you who you are."

And, as has already been said, the solutions are not those offered by contemporary politics. Just as, in *Tools for Conviviality*, Illich hinted that Ralph Nader was a nuisance, not so much because he goaded the car manufacturers, but because he encouraged the further entrenchment of transport as an institution, some of today's "socialist" ideas about redressing the imbalance of equity caused by transport are also impaled: "Imagine what would happen if the transportation industry could somehow distribute its output more adequately: a traffic Utopia of free rapid transportation for all would inevitably lead to a further expansion of traffic's domain over human life." As he remarks later, "To propose (counterfoil) research is politically subversive. It puts in question the overarching consensus on the needs for more transportation which now allows the proponents of public ownership to define themselves as political adversaries of the proponents of private enterprise."

Yet Illich believes that a sane society can be achieved through political means. In *Tools for Conviviality*, he wrote: "Withdrawal from growth mania will be painful, but mostly for members of the generation which has to experience the transition and above all for those most disabled by consumption". For most of us, the problem is how to lay down the burden of our past, without breaking our necks in the process. In Britain, at this moment, there are people—Members of Parliament among them—who talk of participatory democracy. Yet—and I regret my cynicism—I feel it will be a long time before any of them stands up in Parliament, to repeat on his own behalf, Illich's statement: "Participatory democracy demands low energy technology, and free people must travel the road to products: social relations at the speed of a bicycle."

Making institutions work

by Geoffrey Vickers
Associated Business Programmes,
pp 187, £4-00

"It constitutes nothing less than the outline of a new social science," writes Dr Eric Jantsch, a top line futurologist, on the cover of this book. I read it with eager anticipation, and was disappointed.

Making Institutions Work is a collection of lectures and articles, each of which looks at society from a different point of view (education, conflict, money, global equilibrium and so forth). The book is mainly an analysis of the parts of each topic, rather than a recipe for putting the parts together in a more workable way. Thus the chapter on

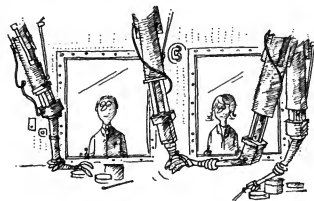
education defines four types of skill (expressive, deductive, creative, appreciative) then breaks down attitudes, knowledge, other inputs than school, various membership groups, and the types of regret a man may feel when he reviews his life. Nine types of education are listed such as: self-development, passing on the heritage, academic skill, critical appraisal, etc. Finally there is a section that describes the many possible roles of the educator. It is all very wise and helpful but does not tell you how to make a rotten educational institution into a good one.

All the chapters are similar; good analysis but little guidance. One theme that runs through all of them is the vital importance of membership. Where

this is used to mean the same as institution then it cannot be denied. It is also used to stress the need for loyalty. This leads to the suggestion that institutional problems are very largely to do with conflicts of loyalty. I found this nonsense. In most dreary institutions there is too much loyalty rather than any conflict.

Many themes reappear in most of the chapters so the book makes for repetitious reading. On the other hand, you can find the author's views on a topic by dipping into a single chapter, and if you read it through you certainly cannot miss his point of view. If you are wondering about how an institution might be made to work you may find some valuable jumping off points, but don't look for answers!

Tim Elliott



Rencin

Robotics

by John F. Young
Butterworths, pp 304, £6.00

The major problem to be solved before robots can make a really effective contribution to taking over repetitive tasks requiring no human judgement, motivation or originality are the provision of sensory adaptiveness of robot hand and body movements to its own perception by touch or vision of variations in surrounding conditions. Young describes a considerable amount of work on vision, character recognition and other sensory systems suitable for robots, but it is clear that we are still a long way from the hand-eye coordination even of an untrained human which would be necessary for the second generation of robots—the first generation of senseless robots are already in widespread industrial use, particularly in Japan.

Young does not tackle the important problem of nomenclature referring to "telechiric devices", which have a remote man in control all the time they are operating variously as manipulators and robots. It is this type of machine which I hope to develop to win coal from dangerous thin or deep seams without men going underground at all, as we win oil, but I prefer to call it a telechiric mole.

He quotes in the first chapter Asimov's three laws of robotics which are laws in the legal sense. I prefer my laws which, like the laws of thermodynamics, can be proved only by the failure of thousands of experiments designed to disprove them. These laws are, I believe, necessary consequences of the fact that robots (unlike humans) are human artefacts. I state them as follows:

- (1) No robot can ever carry out a task more sophisticated or organised than it has been instructed by a human to do.
- (2) No robot can ever invent, create or originate.

Young suggests that random errors must of necessity cause improvements, an idea which was ridiculed by Dean Swift when he proposed that a gallery of monkeys turning dice with words on them could create a book. Eddington's statement that if enough people operate typewriter keys at random for an infinite time they will eventually type all the books in the British Museum is a similar

measure of the fact that creativeness is not a random process.

The most important question of all hanging over the whole future of robotics is that, if they replace all the people doing repetitive, sub-human work in our present economic system, they will simply cause vast unemployment—people would much rather do such work than be paid a dole for doing nothing. In his preface, Young says "the resulting unemployment will simply cause the economy to collapse". I agree entirely that at the same time as we try to free people from sub-human or dangerous work we must change the system. Young does not say how, but I have dealt with this problem in my own book *Machines—Masters or Slaves of Man*.

Although I have taken issue with him on these policy questions, I would thoroughly recommend his book to anyone who wants a clearly written account of the present state of the subject.

Merredith Thring

Machines—masters or slaves of man?

by Meredith Thring
Peter Peregrinus, pp 116, £1.95

Professor Thring returns to (and expands upon) his concept, the Creative Society, first described in his *Man, Machines and Tomorrow* (Review, vol 58, p 435). Few will quarrel with his central theme that industrialisation has led not only to affluence but also to increasing dehumanisation, environmental destruction, and the squandering of natural resources. But how to modify the process, how to describe (much less to quantify) the quality of life? Utopias very properly tend to duck this issue, preferring to hold out the carrot of material affluence. There is the old story of the communist agitator, in full spate, who concluded—perhaps metaphorically—with assurance: "Brothers when the revolution comes, we'll all be eating strawberries and cream." To which someone at the back of the hall ripostes, "But I don't like strawberries and cream." The true authoritarian note puts him in his place: "Brother when the revolution comes, you'll damn well eat strawberries and cream like everyone else."

Having committed all necessary drudgery to machines (tended and repaired by people of low IQ), Professor Thring offers us a William Morris-type

society (itself not undesirable though somehow implausible) in which the creative urge which he posits in all of us is liberated in multifarious and mutually innocuous ways. Work in industry will not disappear, however, but will be rationed to a 20-hour week (or 40 hours for 25 weeks a year or even 20 years in a lifetime). Perhaps a third of us would work on the land and another third would be in "human service activities". The scenario is utterly unexceptionable until the chapter on politics is reached. Thring seems to hanker after Plato's solution (if only we could find the right people) with the addition of the computer to relate decisions to the people's needs. His honest admission that he has no solution to the problem of removing power from a ruling group and transferring it peacefully to another in the state he postulates does him credit. On the other hand, his claim that "if many scientists and engineers devoted a significant proportion of their time to it" we could improve upon the democratic system will cut little ice. The real problem for a humane society is how to identify achievable goals and plan for them, allowing maximum scope for irrationality. Ian Low

How it works

Marshall Cavendish, 98 weekly parts, 30p

Part-work encyclopaedias of this, that, and the other face two problems. Persuading customers to buy the first half dozen parts (and so, the theory runs, the rest of the series) is the easiest. Finding a subject area that no other part-work publisher has yet tackled is much more problematic.

How It Works faces considerable problems of the second kind. There is already a 600 page book *The Way Things Work* (Review, vol 54, p 582), and a rival publisher's part-work. All About Science launched last spring (5p a week cheaper).

How It Works has a considerable advantage over other part-works—it is intrinsically a reference book. Whereas an alphabetical treatment of science is unsatisfactory in many ways, a part-work that builds up into a dictionary, as this one does, is at least feasible. And its market, the curious 11-15 year old, has just about enough pocket money to afford the 30p.

Marshall Cavendish has done its usual competent job. The first issue explains Abacus, A-bomb, Abrasives, Accelerometer (but not accelerators), Accordion and so on. The style of writing is predictably a bit didactic and there are some errors (the section on A-bombs, for example, refers to Einstein's claim that the Germans were already working on a bomb in 1939, but not to Otto Hahn's rebuttal). Physically the book looks good, with lots of full colour photographs and diagrams.

Economics, however, are against it. Buying the whole series would cost almost £30 (admittedly for 4000 pages)—practically 10 times as much as *The Way Things Work*. Another grumble is that although photographers are (rightly) credited, the people who actually wrote the book remain anonymous. Laurence McGinty

A year in Upper Felicityby Jack Chen
Harrap, pp 382, £3.50

Self-reliance and local initiative are the themes that run through this book, where the author describes a year he spent in a Chinese village commune in 1970 during the cultural revolution. Jack Chen, a Trinidadian Chinese, is uniquely equipped to give western readers some idea of what is really going on in China. In 1969 Chen accepted the chance of going to Upper Felicity for a working holiday. Upper Felicity is a village on the Yellow River plain in North Honan Province. This was an abysmally poor region before the liberation. It still is pretty poor, though the peasants now have enough to eat and are managing to control the terrible floods and droughts that ruined their harvests in the past.

Upper Felicity is part of the Great Felicity People's Commune, which has some 28 000 members working in 40 production brigades. The brigade that Chen belonged to had 100 families or 480 people in it. Each brigade is responsible for paying its share of the state grain tax, and for providing the food and welfare of its members. This self-reliance even goes to the extent of growing cotton for their own needs. Each household will spin, bleach, dye and finally weave its share of cotton into cloth. All this is done in the home, except for the ginning, where the peasants use an old electrical ginning machine.

The emphasis in improving the land seems to be to move slowly from small beginnings to bigger things. One example is the way they are tackling the age-old problem of drought. The answer has been to sink deep mechanised wells down to an extensive underwater reservoir, which in Upper Felicity lies some 100 to 130 feet below the surface. A small number of wells are dug each year so the situation improves gradually rather than suddenly. At the same time this gives the peasants the chance to acquire the necessary building skills. The well-digging equipment is loaned by the commune to each brigade but otherwise it is responsible for carrying out the work and for making the concrete well linings.

Apparently it is big-scale enterprises needing capital investments of 20 million yuan (\$8 000 000) or so, which are the responsibility of the central state planning organisations. Smaller scale enterprises needing only local funds can be started by the provinces, counties or communes themselves to satisfy local needs. They will report the input and output involved, but they do not need permission for how they spend their local funds.

Another aspect of Chinese society, which comes over in Chen's book, and which will be appealing to our consumer orientated society, is the careful re-use of all waste. All scraps of food are collected for feeding the animals; when houses are being rebuilt the old walls, which are impregnated with salts, carbon and phosphorus from the fires, are broken up and used for fertiliser, and any bricks, beams or doors are reused.

Jack Chen had a unique experience. His style is to lay detail over detail to give a day-to-day picture of life in Upper Felicity. It is a fascinating account, the only drawback being his totally uncritical description of peasant behaviour. Can it really be true that there is no drunkenness at all?

Sarah White

The limits of natureedited by Jonathan Benthall
Allen Lane, pp 282, £4.00,
£2.50 (paperback)

Trying to pin down the essential aspects of human nature is a bit like the 19th century search for the aether. Whenever one investigator feels he has reached something substantial, another comes along and, by showing up theoretical or empirical inadequacies, neatly pulls the rug from under his argument.

The clue, as Robert Young indicates in his contribution to this collection of talks given at the Institute of Contemporary Arts in London, is to be found in the nature of the project itself. What is important, says Young, is to look at the conceptual apparatus—the classification of what is considered "significant" and so on—by which scientists and social scientists approach the problem.

The analytical categories, he suggests, form part of those ideas which support the particular patterns of social organisation and the control of the society within which the project is carried out. One's ideas about human nature, in other words, are no more than a reflection of one's ideas about human society.

If this sounds a little abstract, then a number of other contributions demonstrate the process at work. The most obvious examples come from the ethologists. Here, behaviour is frequently taken as an indicator of what is held to be natural in any species. Natural evolution is invoked to justify extending the description of animal activity—for example, by the notion of "aggressive instincts"—into an understanding of the behavioural patterns of human societies.

The same behavioural analogies are evident in the two contributions on artificial intelligence. Both Max Clowes and Terry Winograd describe the programming of computers to organise knowledge about an environment in a way that allows the manipulation of objects. They suggest that the lessons one can draw from these experiments about possible ways in which the human brain functions have important implications for our understanding of human nature.

Jean-Marie Benoist neatly maps out some of the pitfalls in this basically empirical and pragmatic approach. Isolating behavioural aspects as the essence of human nature already implies a particular way of looking at the world. Admitting the importance of social and cultural factors which mould this behaviour, if their influence is considered in a purely mechanistic manner, offers no way out of the cul-de-sac.

This is a book to be read with care. It is not a neat summary of what it means to be human. The contributions which, grouped in a section entitled "Evidence",

attempt this task must be read against others which show the distorted perspective within which supposedly-objective facts can be presented, and hence the highly suspect view of a passive, fatalistic human nature which threatens to emerge.

Scientists—and philosophers—may be permitted to theorise about the manner in which we function as biological organisms; but our limits—and our potentialities—as human beings, these we can only find for ourselves.

David Dickson

Monks Wood—**a nature reserve record**edited by R. C. Steele and R. C. Welch
The Nature Conservancy, Natural Environment Research Council, £2

Monks Wood has been well known to British naturalists since the first discovery there of the black hairstreak butterfly in 1828. The wood is probably the best example of the coppice-with-standards oak-ash woodland remaining on the heavy clays that border the western edge of the Huntingdonshire fens. It was appropriate, therefore, that in 1953 it became one of the earliest woodland National Nature Reserves to be declared by the Nature Conservancy. Ten years later, Monks Wood Experimental Station was born on land immediately adjacent to it. As a result, Monks Wood has become one of the most intensively studied sites in Britain and this book aims to bring together, for the first time, many of the fruits of this work.

**SCIENCE
FOR THE
PEOPLE**

David Layton

This book presents an unusual approach to the growth of Science in this country. It is a study in depth of the first major attempt to establish science as a basic component of general education in schools. In particular it examines the question of how science curriculum decisions are made and who determines what scientific knowledge is legitimately incorporated in the school curriculum. £3.55 Illustrated

**George Allen
& Unwin**

The text falls naturally into four sections on physical features, history, the flora and fauna, and management. The value of archival research in ecological investigations has only recently been fully realised and the historical section, written by M. D. Hooper and G. F. Peterken, makes fascinating reading. It throws as much light on the social history of the area as on the ecological history of the wood, and it is particularly revealing when dealing with the pre-Reformation period when the wood formed part of the estates of Sawtry Abbey.

The final section, by R. C. Steele and J. M. Schofield, more or less follows the headings established in the Nature Conservancy's management plan *pro forma*. Those wishing to learn from the Nature Conservancy's experience in reserve management will be disappointed that this section is not more detailed. In particular, there is no information on management costs or reserve income. However, the description of the Event Record Card scheme should be carefully considered by all engaged in reserve management.

The largest part of the book is devoted to a systematic treatment of the flora and fauna so far recorded. This is probably the most comprehensive list so far published for any site in Britain. However, as the authors are at pains to point out, it is inevitably still far from complete, but almost 840 species of plants and almost 3000 species of animals have been recorded. There is a tendency nowadays, in some ecological circles, to consider such exercises in descriptive ecology as somewhat unfashionable and indeed no work of this scale on a single site has appeared since *The Natural History of Wicken Fen*, edited by Professor Stanley Gardiner between 1923 and 1932. However, the current concern with the theoretical implications of such concepts as species diversity are likely to remain highly speculative as long as there remain no actual measurements of diversity for any single ecosystem.

David Streeter

Colour star atlas

by Patrick Moore
Lutterworth Press, pp 112, £2-95

This is an excellent guide to the sky for the newcomer to astronomy who wants to learn his way among the constellations. The dust cover doesn't actually say this, though—instead, it claims to be "invaluable to all observers", "the most comprehensive guide available", and appears to aim at the practising amateur astronomer. Beginners tend to be put off by such things, and believe that everything is going to be too high powered for them. Indeed, this book would be wasted on an amateur astronomer, who has much more suitable star atlases available.

Viewed, then, as an introduction to the sky for the layman, it is very good. Its strength lies in its stimulation of the reader's imagination by using the standard pretty pictures of nebulae taken at Palomar, and by descriptions of the

origin of the universe, galaxies, black holes and so on. Rather unsuitable, but just what the beginner wants. And, a good point, the reader is reminded more than once that the actual telescopic view of the various objects is invariably disappointing compared with the colour pictures.

The colour star maps are the well-known Swiss Hallwag ones, widely available in wall chart form for under £1. Although pretty and informative (despite some strange Germanic additions), their format and colouring make them unsuitable for use by the practical amateur, who wants, say, to plot the path of a comet and rub it out later. To get them into the book, they have been sliced into segments rather inconveniently. Two other sets of maps have been included, which show how the constellations are linked and where to find them—made necessary, I feel, by the awkwardness of the main charts.

The text provides the star-gazer with an accurate and up-to-date view of stellar astronomy and serves to tell him what he's looking at.

There are cheaper, less imaginative sky-guide books available; there are dearer ones which offer better value for money. What a pity then that this book aims at the wrong audience at the wrong price.

Robin Scagell

Cosmic rays at ground level

edited by A. W. Wolfendale
Institute of Physics, pp 232, £12

George Rochester recently retired from the chair of physics at Durham University after a distinguished career in cosmic ray physics. As a tribute to his work, especially in establishing the group at Durham with its wide interest in many ground level cosmic ray phenomena, his colleagues and others who have formerly worked in the laboratory have combined to write this volume.

Rochester is perhaps best known for the experiment performed with Butler in 1947 employing a magnetic cloud chamber to photograph the tracks of heavy, unstable particles among showers of cosmic ray secondaries. The photographs provided the first known examples of "strange particles". Vapour particles as they were then called, and their discovery has led to extensive study within the highly complex world of elementary particle physics.

At sea-level, the primary cosmic ray protons and heavy nuclei give rise to μ -mesons, secondary nucleons, some pions, neutrinos and at very high energies, extensive air showers which mainly consist of cascades of electrons, photons and μ -mesons resulting from a single primary. Various chapters in the volume deal in detail with these different components of the secondary radiation in a comprehensive manner which research workers and students will find most useful. To the more general reader, the chapter on the search for quarks, magnetic monopoles and tachyons may be of particular interest. Quarks are postulated particles

with charge $\frac{1}{3}$ or $\frac{2}{3}$ of the electron charge and from which all known elementary particles are perhaps constructed. Magnetic monopoles may exist if there is symmetry between electric charge and magnetic poles. Tachyons are possible objects which have imaginary rest mass and travel faster than light. The volume reviews present upper limits to the possible intensities of these particles in the cosmic ray flux.

The text is clearly written, contains many useful figures summarising experimental information and the quality of the reproduction is of a high standard.

John Quenby

Photographic sensitivity

edited by R. J. Cox
Academic Press, pp 410, £8-20

Photographic techniques in scientific research, vol 1

edited by J. Cruise and A. Newman
Academic Press, pp 350, £7-06

Nowhere more than in the science of photography has practice run ahead of theory. It was known in the 17th century that the effect of light on powdered silver nitrate was to turn it "black as ink". However, photography as we know it started just under 150 years ago when Daguerre and others introduced the combination of silver halide salts embedded in a gelatin matrix. After some 40 years, the effect of certain dyes in modifying the spectral sensitivity of a photographic film was discovered and the same basic system has been well used since.

Photographic Sensitivity, as R. Colman points out in an introduction, is a series of technical papers on a wide range of aspects of the subject. The first main section of the book is on the formation of the latent image. Articles vary from theoretical essays on quantum mechanics of the photographic process and the mechanism of growth of photolytic silver to more practical considerations of drifting of silver ions in gelatin films. The same diversity of approach characterises the second sections on chemical and spectral sensitivity; these contain detailed descriptions of work on the interaction between silver halide crystals, dyes and light. An article on the spectral sensitisation of semiconductors is included. The last section is on the effect of so-called external factors—humidity, pressure, oxygen—on photographic sensitivity. In all, this is a valuable set of review articles on the recent developments in the subject for specialists.

The volume edited by Cruise and Newman is the first of a planned series. It contains five review articles on different uses of photography. The subjects are living marine animals, aerial soil mapping, insects, palaeontology and the design office. The authors go into the practical problems and techniques associated with the application of photography to these subjects. The result is a group of specialised articles on randomly related topics.

Andrew Miller

AV view

by Richard Whittington

Electronics, explosion or cutback?

The electronics industry is making loud noises about 1974 being a boom year despite ominous noises from the commodities market. Richard O'Brien, vice president of the Sony Corporation of America, has already gone on record as saying that this year is going to be the big year for video cassette sales. He even suggests that the current petrol shortage might provide the impetus for people to adopt video cassettes for product demonstrations. "Business will realise that appreciable cost savings in sales and countrywide communications can be made through video systems."

This is all very fine for America, but what about Britain? So far Sony has delivered only 600 U-matic cassette players, despite a prestige advertising selling campaign aimed at industry. Sony local sales director Trevor MacArthur tells me that he is unable to make any projections about delivery later this year. A commodities dealer I know assures me that the electronics people cannot hope to deliver as they have promised because the availability of essential base materials is becoming critical. For example, gallium arsenide phosphide (PhaGaAs)—used in digital read out assembly—is virtually unobtainable, and Western companies are now looking towards Russia for supplies. Synthetic quartz and silicone slices are also running out. "Don't let electronics companies PR fool you. They are running into problems."

Philips, manufacturers of video cassette equipment and television sets as well as more mundane household products, is keeping a brave face. Bob Livingstone, VCR product manager, relates that already 5000 VCR's have been delivered in Britain and 10 000 more will arrive from Vienna before the end of the year. "We are not worried about source material and have no reason to think deliveries will flag during the year," he says.

Shibaden, major importers of television equipment, denies that the Japanese cutbacks will affect deliveries of the new 1/2 inch colour cartridge playback unit expected here from April. "We have not been told of supply cuts, though we do expect prices to go up," says Shibaden's UK spokesman Norman Simson.

All brave noises, but with commodities hunters looking towards Russia, the prospects for 1974 are hardly rosy.

Big tele leap forward

Speculation that China will adopt the West German PAL television system was strengthened when the Peking Broadcasting Company commenced experimental colour broadcasts recently. Chinese television experts went to Germany last year to study the system and followed up by purchasing television studio equipment. Although China has been broadcasting since 1958, television there has never climbed out of its infant stage. The colour broadcasts suggest a

new impetus. While every provincial capital in China (bar Tibet) has a broadcasting station, according to Japanese sources, there are no more than 100 000 TV sets in operation. That makes one set per 7500 people by my reckoning. Bit of a tight squeeze for Peoples Republic Street or whatever makes popular viewing over there.

Queue no more

Unemployment goes up inexorably. But life for those on the dole remains a miserable experience. One constant problem is how best to inform people of their rights to claim benefit, what kind of training, if any, is available, and how to fill in the endless forms. I cannot help thinking this is one area where the technology really could help. It would not make the problems disappear, but one thing that the Health and Social Security people are prepared to admit is that the present queuing, interviewing and form filling operation leaves much to be desired. "We know that many people have difficulty in filling out forms, particularly the elderly, whose pride often forces them to reject what is theirs as a right. While our staff do their best, the demands on their time and their ability are enormous."

One of the central problems is that interviewers tend to be at the bottom of the social services hierarchy, often earning little more than the interviewees can claim as benefit. Unlike the probation service, which is essentially non-hierarchical and at least makes attempts to be non-bureaucratic, the poorest paid and the least qualified have to carry on the vital face-to-face confrontation while their seniors carry out unspecified functions behind closed doors. Presumably the idea is to inform the unemployed as efficiently as possible of their rights before finding them new work. Attempts have been made to make this information more accessible, using card-filing systems with simple cross-referencing within specific job parameters. If this information were stored on cassettes, the picture would be very different. Instead of the humiliating waiting before being summoned to some peremptory interview ("are they going to stop my benefit, are they going to say no again?"), the process would be immediately decentralised. "Clients," as they are euphemistically

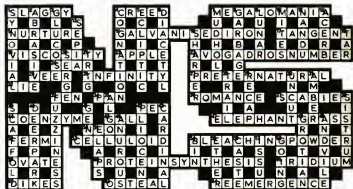
referred to, could select for themselves cassettes on retraining, form filling or job availability and then play them through, either by themselves or in small groups, in specially designed video cassette booths. Other than the investment in actors for the talking heads, the format need not be expensive.

Taking the matter further, this could be interfaced with video lines to other job centres. If the licence for cable stations were relaxed—at the moment they are strictly limited in what they can do—a "jobs available" line could be fed into the facility. Once the major companies knew that employment offices were being equipped with standardised video cassette playback units they would start producing recruitment material to distribute through them. There is already a discernible trend towards in-house production. IBM, Chrysler, Volvo, Abbey Life and Hambro Life Assurance have all moved of late into the cassette network field. An obvious production area would be job selling.

'Ello, 'ello, 'ello

Policemen rarely shine on television. "I was proceeding in a westerly direction when I perceived . . ." continues to astonish those of us who adopt a less formal line in speech. About 18 months ago the powers that be in Scotland Yard decided to encourage their officers to talk like humans when they stood before the cameras. A commercial television company, Hyvision, was brought in to smooth the rough edges and to coach senior officers in the art of television presentation. The scheme has been so successful (well, the PRO at Scotland Yard says it has but I could swear the policemen I see on my set still make odd sounding remarks) that it has now been extended, and a special school for less exalted officers has been opened at Hendon Police College. At the moment, a batch of Metropolitan sergeants are doing their stuff for the cameras at a television studio there. "This time we are handling the whole operation ourselves, using officers who have been trained outside in television techniques to train their own men," chief public relations officer Bob Gregory told me. "Of course I am not sure that a little knowledge is not a dangerous thing," he added ominously.

Christmas crossword: solution



Winners: Dr R. K. Callow, 39 Hendon Wood Lane, London NW7 4HT; Ian Farquharson, Trinity College, Cambridge; CB2 1TQ; D. Sibun, 2 Devonish Road, Abbey Wood, London SE2; Mr. Marie Spragg, 88 Montague Crescent, Garforth, Leeds, Yorkshire; Dr A. G. Touch, "Yonder", Ideford, Newton Abbot, Devon TQ13 0BG.

CLASSIFIED ADVERTISEMENTS

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NEW SCIENTIST
128 Long Acre, London, WC2E 9QH.
Tel: 01-836 2468 Telex: 27253

APPOINTMENTS AND SITUATIONS VACANT

UNIVERSITY OF NIGERIA Nsukka

FACULTY OF PHYSICAL SCIENCES Department of Statistics

(a) Professor, (b) Reader, (c) Senior Lecturers—interests in at least one of the following areas: Statistical Theory, Statistical Methods, Probability Theory, Applied Probability. (d) Lecturers/Asst. Lecturers Nsukka/Calabar Campuses—interest in statistics or probability.

Qualifications and Duties: Candidates for the post of Professor, Reader, Senior Lecturer or Lecturer should possess advanced (preferably doctorate) degrees in relevant fields with university teaching and research experience and evidence of productive research. Successful candidates will teach courses to undergraduates and postgraduates as well as conduct research.

Candidates for Assistant Lectureship should possess a good first degree plus an advanced degree with some teaching/research experience in relevant fields. Successful candidates will teach undergraduate courses and participate actively in conducting research.

Salary scales: Professor SG.2-N6800 (consolidated); Reader SG.4-N6100 (Consolidated); Senior Lecturer SG.3-N5300 x 150; N5480, N5750; Lecturer SG.7-N2760 x 150-N3560 (bar); N310 x 150-N4290, N4530 x 150-N4830; Assistant Lecturer SG.12-N2140 x 150-N2540 x 100-N2840 p.a. (OR N2460 x 100-N2650 for appointees over 28 with higher degrees).

Conditions of service: Fare paid for appointee, wife and up to five children under eleven years of age on appointment; leave after 21 months' tour and termination. Children and car allowances, superannuation scheme, free medical services, part-furnished accommodation at standard rent rates.

Method of application: TEN copies of typewritten application giving details of educational background, institutions attended and qualifications, teaching/research experience in institutions and dates, nationality, marital status, age, list of publications (if any) and names and addresses of THREE referees competent to attest to candidates' academic/professional abilities. To: THE PERSONNEL OFFICER, University of Nigeria, Nsukka, Nigeria, quoting ref. JN/SSA/FFS/STATS/73, by 8 February 1974.

ROYAL POSTGRADUATE MEDICAL SCHOOL JUNIOR TECHNICIAN (aged 16-18)

required in Biochemistry Research Laboratory, in Department of Medicine. Minimum qualifications G.C.E. Levels passes in English, Maths and two Science subjects. Salary according to age and qualifications.

Applications to the Secretary, Royal Postgraduate Medical School, Hammersmith Hospital, Du Cane Road London W12 0HS quoting reference 2/356/N5.

Clinical Chemists

The Searle Group is a leading research-orientated company in the pharmaceutical industry.

Scientists are required to join an expanding department concerned with the development of diagnostic products, reagents and methods. Applicants should have qualifications such as BSc or FIMLT in Biochemistry, Clinical Chemistry or a related science, but a good scientific attitude is as important as the precise field of study. Experience of general clinical chemistry, enzymology, immunology or radioimmunoassay is desirable for some of these posts, which should appeal to those interested in seeing practical use made of their work.

Salaries are attractive and negotiable and Company benefits include: a contributory Pension Fund, BUPA membership scheme and 4 weeks holiday. Please apply in writing giving full details of career and education to:

J N Williams
Assistant Personnel Manager
Searle Diagnostic
G D Searle & Co Ltd
Lane End Road
High Wycombe, Bucks.

SEARLE

MATHEMATICS/COMPUTING/PHYSICS SCIENTIFIC ASSISTANT

We have a vacancy in our Research Laboratories for an Assistant to operate and assist in developing an advanced computer controlled MASS SPECTROMETER SYSTEM.

Candidates must have at least "A" level passes in Mathematics and Physics. Practical experience of computers and electronics would be an advantage.

Competitive starting salary, progressive according to merit. Working conditions are good. There is a minimum of three weeks' holiday progressing to four weeks. Ample car parking, first-class restaurant facilities, active sports & social club, and many other benefits.

Applications in writing to:

Mr. F. Houlston,
Group Research & Development Centre,
British-American Tobacco Co. Ltd.,
Regents Park Road, Southampton, SO9 1PE.

UNIVERSITY OF NAIROBI —KENYA

Applications are invited for the following posts in the Faculty of Agriculture:

1. SENIOR LECTURER

IN DEPARTMENT OF CROP PRODUCTION. Applicants should have a good degree in Agriculture and a postgraduate degree in Crop Science or Horticulture. They should have teaching, research and field experience. Appointees will be expected to teach undergraduate courses in Crop Production and/or Horticulture, to supervise postgraduate students and to assist in developing the Faculty's Experimental Field Station.

2. LECTURER

IN DEPARTMENT OF CROP PRODUCTION. Applicants should have a good degree in Agriculture, Horticulture or Botany with a postgraduate degree in General Agronomy, Horticulture or Plant Physiology. Experience in teaching and/or research will constitute a recommendation. Appointees will be required to undertake teaching of the production of crops to undergraduate students and to guide and teach postgraduate students.

3. LECTURER

IN DEPARTMENT OF AGRICULTURAL ECONOMICS. Applicants should have a degree in Agricultural Economics, preferably with research background in tropical agriculture. Duties of the appointee will involve lectures and practicals with undergraduate students and research supervision of postgraduate students. Applicants should have their main training and interest in the following fields: Agricultural Economics and Farm Management or Rural Sociology and Agricultural Extension.

Salary Scales: Senior Lecturer K2256-E3036 p.a., Lecturer K1500-K2280 p.a. (K1 = £1.24 sterling). The British Government may supplement salaries in range £450-£550 p.a. (sterling) for married appointees or £150-£550 p.a. (sterling) for single appointees (normally free of all tax) and provide children's education allowances and holiday visit passages. FSSU. Family passages; various allowances. Detailed applications (2 copies, including a curriculum vitae and names of referees, should be forwarded by air mail, not later than 15 February 1974 to the Registrar, University of Nairobi, P.O. Box 30197, Nairobi, Kenya. Applicants must also send 1 copy to Inter-University Council, 96/91 Tottenham Court Road, W1P 0DT. Further particulars of these appointments are obtainable from either address.

CHELSEA COLLEGE University of London

TECHNICIAN (Grade 3)

whose main duties will be in assisting in teaching and research in Neurophysiology. Experience with animal experiments and an expertise in electronic design is desirable. Salary Scale: £1825-£2050 per annum (including London Allowance). Application forms from the Personnel Officer, (NS), Chelsea College, Manresa Road, London, SW3 6LL. Closing date 8th February 1974.

NATURAL ENVIRONMENT RESEARCH COUNCIL

Institute of Geological Sciences

There is a vacancy for a
SCIENTIFIC OFFICER

in the Geomagnetism Unit at
Hertsmenceux Castle, Sussex, for
an initial period of one year.

DUTIES

The Unit is concerned with the collection and exploitation of world-wide geomagnetic observations and is also responsible for three permanent magnetic observatories in the United Kingdom. The successful candidate will be a member of a small research team engaged in the analysis of world-wide data and the theory of changes in the geomagnetic field having periods ranging from a few hours to many years, and may be called upon to assist in other aspects of the Unit's work. Most of the data are in machine-readable form and the work will involve extensive use of an electronic computer.

QUALIFICATIONS AND EXPERIENCE

Candidates should normally hold a degree with 1st or 2nd class honours, or equivalent qualifications, in Mathematics, Physics or Geophysics, or have had extensive appropriate experience. A working knowledge of Fortran is desirable.

SALARY SCALE

£1318-£2177 per annum. Starting salary may be above the minimum.

The staff of the Council are not Civil Servants but their pay and conditions of service are similar to those of scientists in the Civil Service.

Application forms available from Establishment Office, Institute of Geological Sciences, Exhibition Road, London SW7 2DE (quoting No. SO/GM/74). Closing date 1st March 1974.

THE MARIE CURIE MEMORIAL FOUNDATION, Research Department, The Chart, Oxted, Surrey. RH8 0TN.

Applications are invited for the following posts:—

Endocrinology Unit: Technician/Junior Technician required to participate in biochemical research into the role of hormones in the induction and growth of mammary tumours. Experience in general biochemical techniques an advantage.

Tissue Culture and Cytogenetics Unit: Junior Technician required to participate in research into the tissue culture and cytogenetics of tumour cells. Relevant experience an advantage but not essential.

Salary according to Whitely Council Scales. Applications with names of two referees to be made to the Secretary at the above address.

The Hatfield Polytechnic

Department of
Chemical Sciences

Research in CHROMATOGRAPHIC and POLYMER Science or THERMODYNAMICS

Applications are invited for a Research Assistantship to work on aspects of the physical chemistry of solutions or on the development of novel column materials for gas and liquid chromatography and their application to the study of antioxidant behaviour.

Applications forms may be obtained from The Staffing Office at Hatfield Polytechnic, PO Box 109, Hatfield, Herts AL10 9AB. Hatfield 68109, Ext. 309.

Further details may be obtained from Dr. W. Boardman, Head of Department, Ext. 329. Please quote ref: 449.

**unilever
research**

Scientist

Creative Product Development

A Scientist is required to join a group of staff who are devising new toiletry products and assessing the consumer response to them. The work involves the creation of new products with particular emphasis on those factors which affect their acceptability to consumers. This will involve close working relationships with groups engaged in product development and consumer studies.

The vacancy is at the Company's Toilet Preparations R. & D. Laboratory which is situated on a well appointed site ten miles west of central London.

Candidates should have a degree (Ph.D preferred) in science with some chemistry and preferably some experience in the development of consumer products. They should also have demonstrated CREATIVE FLAIR and possess the ability to communicate ENTHUSIASM verbally and in writing. Training will be given to the successful candidate who has the desired personality but lacks appropriate experience.

Commencing salary is negotiable from £2,550 per annum at age 24. Fringe benefits in addition to flexible working hours, include a Company Superannuation Scheme, Staff Restaurant and a Sports/Social Club on site in addition to the amenities of a modern research laboratory.

For an application form or any additional information, please telephone or write to:

The Personnel Manager,
Unilever Research Laboratory,
455, London Road,
Isleworth, Middlesex.
Telephone: 01-560-1266
Quoting Reference: 19J/M.



Design Engineers

Two young engineers are needed to participate in an expansion of current projects in the Wilkinson Sword Research Laboratories.

The projects are aimed at the introduction of new products and will involve design of small mechanical devices and instruments.

Those appointed will wish to follow through this work and be involved in:—

- supervising methods of manufacture
- testing
- collaboration in development for production of successful products.

Full technical support is available from a modern research laboratory and well equipped workshop.

Suitable candidates will have, or be studying for, a degree or equivalent qualification.

Please apply to:

Or telephone:

Personnel & Administration Manager,
Wilkinson Sword (Research) Limited,
Colnbrook, Slough, Bucks, SL3 0HA.
Colnbrook 3811 Ext. 25.

A career in Information Science

The ERA Industrial Communications Department provides a wide range of sophisticated library and information services externally to clients and internally to our technical staff. Services provided include abstract bulletins, computer aided current awareness, technical literature searches, translations, enquiry answering and sales of publications.

We are now seeking to strengthen the existing team by the following two appointments:

Information Scientist

The one *essential* for this post is previous experience in information or library work. Ideally, we would like you to have in addition a professional or graduate qualification, a background in the electrical or allied sectors of industry, some abstracting experience, and a knowledge of a foreign language.

Professional Trainee

The successful candidate will be required to attend a day-release course in either Information Science or Librarianship. Preference will be given to applicants who already have previous relevant experience, or have a technical background, or a knowledge of a foreign language, but we would like to hear from you if you have a genuine interest in and aptitude for this type of work.

Please write to or telephone:

The Personnel Manager,
The Electrical Research Association,
Cleve Road, Leatherhead, Surrey.
Tel: Leatherhead 75141.

THAMES POLYTECHNIC School of Biological Sciences Division of Environmental Biology

Applications are invited for a
RESEARCH ASSISTANTSHIP
to undertake studies on the micro-bial dissimilation of the halogenated phenoxyacetate herbicides.

Applicants should hold a good honours degree in Microbial Biochemistry, Biochemistry or Chemistry. Industrial experience and some training in Microbiology are preferable though not essential.

The successful candidate will receive a starting salary of £1427 per annum and will be expected to register for a higher degree.

Further details and application form may be obtained from the Secretary, Thames Polytechnic, Wellington Street, London, SE18 6PP, to whom completed applications should be returned by 12 February 1974.

SHEFFIELD POLYTECHNIC Department of Mathematics and Computing Science SENIOR TECHNICIAN

Applications are invited for a Senior Technician, responsible primarily for the upkeep of the Departmental Laboratories. A good knowledge of Mathematics, Statistics or Computing and/or practical and electrical applications would be an advantage.

Salary Scale: T4: £1644-£1926, plus qualification allowance of £42 or £72.

Application forms obtainable from the Staffing Officer, Sheffield Polytechnic, Halfords House Fitzalan Square, Sheffield, S1 2BB, to whom completed forms should be returned within fourteen days.



Wellcome

Biochemist

There is a vacancy in the Department of Biological Chemistry for a Biochemist to take part in a programme of work on chalcones. Some knowledge of modern biochemical separation techniques is required and an interest in the process of cell division would be an advantage. The candidate should be prepared to undertake research of a fundamental kind and will be involved in collaboration with a university department.

The appointment carries excellent conditions of employment in modern well-equipped laboratories located in pleasant parkland surroundings convenient for Beckenham, Bromley and Croydon.

Applications, giving brief details of background and experience, should be sent, quoting reference AQ.435, to:

The Personnel Manager:
Wellcome Research Laboratories
Langley Court
Beckenham, Kent BR3 3BS



METAL BOX CO. CORPORATE R & D ACTION CHEMIST

The Printing Sciences and Reproduction Section at Action needs a Graduate Chemist to join a small team working on the evaluation and development of new types of fast curing printing inks and coatings for containers and packaging materials.

Candidates should have had at least 2-3 years post-graduate experience of Polymer Chemistry or in the formulation and testing of printing inks, surface coatings or synthetic resins.

The starting salary offered will depend on qualifications and experience, while there is ample scope for further advancement depending on ability and achievement.

Please apply to: Administration, The Metal Box Co. Ltd., Research & Development Dept., Kendal Avenue, Westfield House, London, W3, Tel No.—01-992 3411 Ext. 352.

THE LONDON HOSPITAL MEDICAL COLLEGE

(University of London)

TECHNICIAN/SENIOR TECHNICIAN

Department of Oral Pathology

Technician / Senior Technician required to be responsible for a small Tissue Culture Unit which has an appendage of a large well-equipped parent department. Experience in histological techniques essential but not necessarily of tissue culture. Candidates must be in possession of AIBML, HNC, City and Guilds or some other appropriate qualification. Salary within Whitley Council Scales for Medical Laboratory Technicians. Enquiries to Professor A. E. W. Miles, Tel. 01-247 5454 Ext. 89. Applications giving full details of qualifications and experience to the Secretary, The London Hospital Medical College, Turner Street, London, E1 2AD, within 14 days, quoting reference OP/2/74.

ROTHAMSTED EXPERIMENTAL STATION Harpden, Herts. AL5 2JQ SCIENTIFIC OFFICER

to work in the Entomology Department on aspects of insect behaviour leading to the improvement of current methods of pest control. The work will consist initially of establishing and maintaining insect cultures, with opportunities to participate in other laboratory and field research. Minimum qualifications: Degree in Entomology, Zoology or Invertebrate Physiology, HNC or the equivalent in a biological subject. Starting salary £1318-£1590 according to qualifications and experience, on a scale to £2177. Superannuation and non-pensionable allowance to offset personal contributions.

Applications, naming two referees and quoting reference 2195 to the Secretary by 11th February, 1974.

KING'S COLLEGE HOSPITAL MEDICAL SCHOOL (University of London)

Denmark Hill,
London, SE5 8RX

Senior Research Biochemist required to join multidisciplinary group working in field of liver metabolism and drug hepatotoxicity. Ph.D. preferred. Facilities for higher degree. Salary within range £2385-£2880 plus £126 London allowance. Further particulars from Dr R. Williams, Liver Unit. Applications to the Secretary of the Medical School (NS) not later than 15 February, 1974.

**NATIONAL INSTITUTE
FOR BIOLOGICAL STANDARDS & CONTROL
HAMPSTEAD — LONDON**

JUNIOR TECHNICAL OFFICER/TECHNICIAN

required in the Antibiotics Division to work in a laboratory concerned with the evaluation and control of antibiotics used in therapy. Candidates should possess a degree/HNC or equivalent in one of the biological sciences. Graduates will be appointed to the Junior Technical Officer scale between £1535-£2199 p.a. Holders of HNC or the equivalent will be appointed to the Technician grade £1566-£2418 p.a. Experience in antibiotic assay by microbiological and chemical procedures is desirable. Please quote ref: JTO/NIBSC/A

JUNIOR TECHNICIANS (female)

are required in the Viral Products Division which is concerned with the control of immunological products, and in the Division of Bacterial Products which deals with the potency and safety testing of bacterial vaccines. A full training will be provided and Junior Technicians are encouraged to follow higher qualifications by day-release study. Applicants should have a minimum of 4 GCE 'O' levels including biology, mathematics and english. Salary on scale £534 p.a. (et age 16) - £1461 p.a. Please quote ref: JT/VP/BP

Candidates for these posts should contact Mr. P. A. Collingridge, National Institute for Medical Research, The Ridgeway, Mill Hill, London, NW7 1AA, Tel: 01-959 3666

**NATIONAL INSTITUTE FOR MEDICAL RESEARCH
MILL HILL — LONDON**

JUNIOR TECHNICAL OFFICER

required in the Division of Immunology to assist in research on cellular immunology using biochemical and tissue culture techniques. Candidates should be recent graduates in biochemistry or zoology. Salary on scale £1535-£2199 p.a. Please quote ref: JTO/Imm

JUNIOR TECHNICIAN

for Division of Immunology to assist in research on cellular aspects of the immune response. The work will involve the development of new genetic lines of laboratory mice. Candidates should have a minimum of 4 GCE 'O' levels including maths, biology and chemistry and preference will be given to those with 'A' levels or ONC. Salary on scale £534 (et age 16) - £1461 p.a. Please quote ref: JT/Imm

JUNIOR TECHNICIAN

in the Laboratory of Peptide Chemistry to assist in the synthesis and purification of peptide hormones and their biological activity in animals. Candidates should possess GCE 'A' level in chemistry and, preferably, in biology or an ONC in chemistry. Previous laboratory experience is not required as training will be given. Opportunities for further study will be provided. Salary on scale £564 p.a. (et age 18) to £1521 p.a. Please quote ref: JT LPC

Applicants for these positions should contact P. A. Collingridge, N.I.M.R. The Ridgeway, Mill Hill, NW7 1AA, Tel: 01-959 3666, with details of their age, qualifications and experience.

**Assistant to Purchasing
Officer**

The National Institute for Biological Standards and Control has a vacancy for an assistant to the Purchasing Officer whose section is responsible for providing supplies services to a growing and important Scientific Establishment.

The person appointed will assist at all levels, including, ordering supplies—planning and budgeting for future needs—maintaining expenditure control and assisting in the overall supervision of the Central Store.

The post would particularly appeal to someone who enjoys working in a scientific environment; he or she should be able to perform their duties unsupervised and on their own initiative. There is the opportunity for the right candidate to develop with the post particularly as he or she will be closely involved with planning of requirements for a new enlarged Institute to be sited at Potters Bar.

There is an active sports and social club and the Institute is situated in pleasant surroundings close to Hampstead Underground Station.

Salary on a scale rising to £1850 (a salary increase is pending) plus superannuation benefits and generous holidays.

Write to Robin Dunn, Personnel Officer, National Institute for Biological Standards and Control, Holly Hill, Hampstead, N.W.3, or for further information and an application form telephone—435 2232.



Wellcome

**Information
Scientist**

A vacancy has arisen in the Research Information Centre for a graduate biochemist, pharmacologist or pharmacist. The Centre comprises a team of young graduates and associated staff developing information handling techniques in support of the Company's research and development effort. The Company possesses a 1903S computer and automation of information storage and retrieval is well advanced.

The successful applicant will be expected to undertake certain routine duties such as literature searching and indexing of company reports relating to research and development in the biochemical/pharmacological field. There will also be participation in project and study groups and the position requires initiative and an ability to communicate with scientific staff.

Candidates should be between 22 and 35 years of age and possess an Honours degree in an appropriate subject. Preference will be given to applicants with relevant experience and/or post-graduate qualifications.

The laboratories are situated in pleasant parkland surroundings and conditions of employment are attractive.

Applications, giving brief details of background and experience, should be sent, quoting reference AQ.434, to:

The Personnel Manager
Wellcome Research Laboratories
Langley Court
Beckenham
Kent BR3 3BS



St. Peter's Hospitals

**Laboratory
Technicians**

Male or Female

This small group of four postgraduate teaching hospitals require a Laboratory Technician to work in the E.C.I. Unit.

Applicants should possess or be studying for the O.N.C. in Medical Physics or similar (for which day-release may possibly be arranged). Salary will be paid according to qualifications and experience.

For an application form contact the Personnel Officer, St. Philip's Hospital, Sheffield Street, London WC2A 2EX (01-242 9831 Ext. 37).

FORENSIC SCIENTISTS

Vacancies exist for Scientific Officers, Higher Scientific Officers and Senior Scientific Officers in the CHEMISTRY and BIOLOGY Divisions of the Laboratory.

CHEMISTS

Chemistry Division is engaged in the examination of a wide range of materials occurring both as traces, transferred between the criminal and the scene of the crime, and in many other situations in relation to criminal offences. It includes a drugs and toxicology section.

BIOLOGISTS

Biology Division deals with the examination, identification and comparison of body fluids, fibres etc.

Qualifications: A degree, HNC or equivalent in an appropriate subject is essential. For SSO, 1st or 2nd honours degree or equivalent is necessary, with at least 4 years' postgraduate experience, and aged under 32. At least 2 years' postgraduate experience is needed for HSO, and aged under 30. For SO age must be under 27.

Those who expect to qualify this summer are also eligible to apply.

Salaries (under review): SSO: £2,790-£3,815, HSO: £2,251-£2,842, SO: £1,493-£2,352.



Application forms (to be returned by 22nd February) and further details are available from:- The Secretary, Room 733 (LAB/ NS), New Scotland Yard, Broadway, London SW1H 0BG, or telephone 01-230 3122 (24 hour answering service).

Metropolitan Police

THE CAMPDEN FOOD PRESERVATION RESEARCH ASSOCIATION

Invites applications for the following posts:
(a) Librarian/Scientific Information Officer to operate the library, carry out abstracting and keep an information index up-to-date. Candidates should preferably have a degree in a scientific discipline.

(b) Two Graduate, Analytical Chemists, one with special responsibility for the development of automated techniques, the other to be responsible for long and short term projects with the Food Industry.

(c) Graduate microbiologist to join a group carrying out applied research and "trouble shooting" activities in connection with the safety of all forms of processed foods.
(d) Project Engineer to deal with the processing of foodstuffs. Applicants should have adequate qualifications with preferably some experience in the Food Industry.

The posts are graded on the Research Officer salary scale £1368-£2484. Exceptional candidates for post (a) may be placed on the Senior Research Officer Scale £2220-£3312.

For further details write to The Director, The Campden Food Preservation R. A., Chipping Campden, Gloucestershire GL53 6LD.

KING'S COLLEGE HOSPITAL MEDICAL SCHOOL

(University of London)

Denmark Hill, London, SE5 8RX
Science graduate with experience, preferably in tissue culture, immunological methods and cytogenetics, required to work as a Research Assistant in the Genetics Laboratory. The successful applicant will be expected to participate in a project concerned with the diagnosis of cancer. Salary according to age and experience. Applications in writing with the names of two referees to the Secretary of the Medical School (NS) not later than 14 February, 1974.

ROYAL POSTGRADUATE MEDICAL SCHOOL

TECHNICIAN/
SENIOR TECHNICIAN

Required for work on the virology of patients with infectious diseases. Experience in virology (Serology and cell culture in particular) is required. Appointee will also be expected to participate in the work of the routine clinical virology section. Qualifications HNC or equivalent. Salary according to qualifications and experience.

Applications to the Secretary, RPHS, Hammersmith Hospital, DuCane Road, London, W12 0HS, quoting Ref 10/246/NS.

QUEEN ELIZABETH COLLEGE

(University of London)

Campden Hill Road, W8 7AH
TECHNICIAN GRADE 6

required in the DEPARTMENT OF FOOD SCIENCE to take responsibility for teaching laboratories and assist with research.
Applicants should have HNC/HND (or equivalent qualifications) and experience of analytical and/or food chemistry. Ability to operate and maintain chromatographic and spectrophotometric instruments essential. Salary scale £2,545 to £84,£3,049.

Apply in writing, giving names of two referees, to Dr. I. D. Morton. (NS)

MECHANICAL ENGINEER

with a good honours degree or equivalent is required by a large industrial research and development organisation. Post requires an interest in the instrumentation and design of metal working and shaping equipment and in all aspects of the working of metals. Preferred age up to approximately 28 years.

Write in the first instance to The Secretary, The British Non-Ferrous Metals Research Association, (Ref. AC-25), Grove Laboratories, Denchworth Road, Wantage, Berkshire, OX12 9BJ.

IMPERIAL COLLEGE, LONDON

RESEARCH OFFICER

Radiowave Propagation

Research Officer required for full-time research into millimetric-wave propagation and underground propagation, under the direction of Professor John Brown. Applicants should have a liking for both theoretical and practical aspects of the work and will be expected to organise field trials. A degree or equivalent qualification and relevant experience are required.

The starting salary will be £2553 plus £162 London Allowance p.a. The post will be for one year initially but may be extended to three years, with annual increments of £165 per annum.

Apply in confidence to H. Page, Electrical Engineering Dept., Imperial College, London, SW7 2AZ.

THAMES POLYTECHNIC School of Architecture

LECTURER II IN ENVIRONMENTAL SCIENCE

The School of Architecture needs an environmental scientist, environmental engineer, or other suitably qualified graduate, to teach the application of environmental science to building. Applications from recently qualified graduates who have an interest in this field will be welcomed.

The successful candidate will be a member of the teaching Division of Construction Technology, which is part of the Faculty of Architecture and Surveying, located at Hammersmith, London, W.6 and will also be associated with teachers of Physics and Materials Science at the Woolwich site of the Polytechnic. Personal interests and research in solar radiation or acoustics will be encouraged.

Applicants should have HNC/HND (or equivalent qualifications) and experience of analytical and/or food chemistry. Ability to operate and maintain chromatographic and spectrophotometric instruments essential. Salary scale £2,545 to £84,£3,049.

Apply in writing, giving names of two referees, to Dr. I. D. Morton. (NS)

Salary scale: £2515-£3245 + £118 London allowance.

Further particulars and form of application may be obtained from the Secretary, Thames Polytechnic, Wellington Street, London, SE18 6PF, to whom completed applications should be returned by 12 February 1974.

RESEARCH ASSISTANT required in Department of Medical Microbiology to join research team concerned with the serological studies of Gram-negative bacteria. Commencing salary up to £1682 dependent on qualifications and experience. Appointment to terminate 31 October, 1975. Applications in writing to the Secretary, The Medical College of St. Bartholomew's Hospital, West Smithfield, London, EC1A 7BE, quoting reference 625.

Process Development to meet new needs in a vital industry

We are Europe's largest animal feed manufacturers and part of the Unilever group. We need a Development Officer, who will be a senior member of our Process Development department, based at Avonmouth near Bristol.

This position offers challenging opportunities for a person with an enquiring mind and an aptitude for innovation. The work will involve planning and implementing experimental design projects not only at Avonmouth but at other locations in the UK - putting forward new ideas and suggestions for improving the efficiency of compound processing - helping to design pilot plant - assisting with the commissioning of new plant and training operatives in its use.

Candidates, preferably aged under 30, should have a higher or good class honours degree in Pure or Applied Science. They should be familiar with development work, not necessarily in animal foods or an allied field. In addition to an attractive salary, the company offers excellent conditions of employment, including assistance with relocation expenses where appropriate.

BOCM SILCOCK



Please write giving brief career details, quoting reference AQ.20, to: John Hollier, Company Personnel Manager, BOCM Silcock Ltd., Basing View, Basingstoke, Hants.

Drug Metabolism/ Pharmacokinetics

A vacancy has recently arisen for a technician in the drug Metabolism Section of the Wyeth Institute of Medical Research. The work involves studying the absorption, distribution, metabolism and excretion of potential drugs in animals and man.

The ideal candidate will be between 19-23 years of age, qualified to O.N.C./H.N.C. standard or with an equivalent qualification. Previous experience in this field is desirable but not essential.

The section is well equipped for liquid scintillation counting, gas liquid chromatography, fluorimetry, etc., and the main laboratory has recently been refurbished.

Please send curriculum vitae to:

Mrs. J. Andrews
John Wyeth & Brother Ltd.
Huntercombe Lane South
Taplow, Maidenhead
Berk



JUNIOR TECHNICIAN required for Department of Physiology to assist in research in cell studies and in class work. "O" or "A" levels in Biology or equivalent experience required. Whitley Council Scale. Applicants to send curriculum vitae to: School Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, WC1N 1BP.



URGENT CALL TO SCIENTISTS & TECHNICIANS

Find out about all job opportunities presently available in Hospitals, Research Institutes, Pharmaceutical & allied industries. We have immediate vacancies for all grades of Technicians Research Assistants & Medical & Technical Representatives. For details of our free service write or phone Miss Eames or Miss Maranelli, G.K. Bureau, 17 Shaftesbury Ave. W.1. Tel. 01-734 7232.

**unilever
research**

Clinical Biochemistry Technician

An experienced Technician is required to be responsible for carrying out clinical chemical analyses in our Environmental Safety Division.

Applicants should have experience of automated analytical methods, especially those using the Auto-analyser.

Salary in the range £1200-£1950 per annum according to qualifications and experience.

Colworth House is situated in a pleasant country estate 10 miles north of Bedford, and is responsible for research relating to Unilever's world-wide industries.

Applications should be sent to:

Mrs. C. Holbrook, Personnel Officer,
Unilever Research Laboratory,
Colworth House,
Sharnbrook, Bedford, Beds.



Glaxo

Start your Career in Electronics

If you have studied to 'A' level standard in science subjects and have an interest or some experience in electronics, this could be just the opportunity for you. We need a Junior Electronics Technician in our Physical Chemistry Department for duties which include construction of new apparatus and maintenance of electronic instruments used in chemical laboratories.

We will give time off to study for further qualifications. In addition to an attractive salary, which is regularly reviewed, we offer excellent conditions of employment including a bonus scheme.



Please apply quoting ref. AQ.674 to the Personnel Officer (Research), GLAXO LABORATORIES LTD., Greenford, Middlesex.

JUNIOR RESEARCH TECHNICIAN required for drug measurement in patients. Four "O" levels (preferably two in science). Day release encouraged. Salary on scale £505-£1394+£126 London Allowance, with placement according to age and experience. Applications to Dr A. Richens, Clinical Pharmacology, St. Bartholomew's Hospital, London, EC1A 7BE.

Laboratory Service Manager

Hoechst Chemicals have recently established a new modern and well equipped C2m laboratory at Milton Keynes.

A first class opportunity exists for a person to assist in the establishment of a general service function for high level graduate research staff.

Applicants should be qualified to at least HNC, or equivalent and be able to back this up with several years' experience at supervisory level in a laboratory service environment. A sound background and awareness of the equipment requirements of biological and chemical laboratories is essential, whilst a knowledge of systems analysis and computerised inventory control and ordering would be an asset.

Reporting to the Head of Administration, the duties will involve all

aspects of material and equipment control, purchasing, maintenance, security and transport matters. He will be expected to maintain close liaison with department heads and other functions on all matters relating to these areas.

This appointment carries a realistic and competitive salary in addition to which there are attractive company benefits.

Please write, with brief but sufficient career details, to:

Mr. S. Friedlander, Personnel Officer
Hoechst Pharmaceuticals Limited,
Watson Manor,
Walton,
Milton Keynes,
Bucks, MK7 7AJ

Tel: Pineham 5068



ASSISTANT SCIENTIFIC OFFICER

required for technical work in the Entomology Branch.

Duties include rearing and microscopic examination of forest insects and giving technical assistance with laboratory experiments and analytical procedures.

Qualifications: At least 4 GCE 'O' levels or equivalent including English language and mathematics or a science subject. Some laboratory experience is preferred.

Age: At least 16 and normally under 26

Salary: £675 (age 16) rising to £1397 (age 26) rising by annual increments to a maximum of £1612. Four weeks annual holiday. Good career prospects.

Closing date: 8 February, 1974.

Application forms from: Establishments Officer, Forestry Commission Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey. Tel: Bentley 2255.

THE UNIVERSITY OF SUSSEX

School of Biological Sciences
RESEARCH ASSISTANT IN ANIMAL BEHAVIOUR

Applications are invited for the post of Research Assistant to help with a project on the temporal pattern and causation of behaviour in passerine birds. Candidates should preferably have a degree in Biology or Psychology, but those with a mathematical background and an interest in animal behaviour will also be considered.

The post is tenable for three years from 1 March, 1974, with salary in the range £1002 x 60—£1562.

Further details and application forms may be obtained from the Secretary of Science, Science Office (E), University of Sussex, Falmer, Brighton, BN1 9RH.

JUNIOR TECHNICAL OFFICER required by Institute of Cancer Research in the Immunobiology Department of the Chester Beatty Research Institute, F. F. Road, London SW3. Two 'A' level science subjects are the minimum qualification and experience in tissue culture methods would be an advantage. The work will be on a project designed further to explore the nature and functions of the lymphoid system in mice. Salary on MRC scales. Apply in duplicate, giving names of two referees to the Secretary, Institute of Cancer Research, 34 Summer Place, London SW7 3NU, quoting Ref. No 301/499.

Technical Assistant Southall

SALARY on age scale, rising to £1414 per annum (inclusive of £90 London Allowance at 24, plus, dependent on age, £156 or £208 per annum Efficiency Payment after 3 months' satisfactory service.

Other benefits include:

- 3 weeks annual holiday
- 11 days Bank and Public Holidays
- Canteen facilities
- Sick Pay
- Pension Scheme

The Board require in their Research Station at Hayes Road, Southall, a Technical Assistant to assist with the design and construction of hydraulic models, preparation of engineering drawings, graphs and figures and the collection and analysis of model and survey data. The ability to fabricate small engineering assemblies and an interest in photography would be an advantage, but training will be given in all aspects of the work. Some travelling is required and the possession of a current driving licence essential.

Applicants should have 4 'O' levels and it would be an advantage if studying for 'A' levels or equivalent. Continuation to HNC or equivalent will be expected for which purpose one day release per week will be allowed.

Applicants are invited to write for an application form to the **Chief Personnel Manager, British Transport Docks Board, Melbury House, Melbury Terrace, London, NW1 6JY**, or telephone 01-496 6641, extension 6288 and speak to Mr. Whittington.

British Transport Docks Board

A Nationwide Ports Service

LONDON BOROUGH OF BARNET Education Department LABORATORY TECHNICIAN (MALE)

required at Woodhouse School, Woodhouse Road, North Finchley, N12, to work in Physics and Technical Departments. Duties include assembly, care and maintenance of apparatus, preparation of equipment and use of materials, etc. Applicants should have several years' experience and preferably hold the City and Guilds Science Laboratory Certificate (or equivalent) for which additional salary allowance will be made. Excellent facilities. Five-day, 36-hour week. Permanent Superannuable post. Commencing salary within Technician Grade 4, Scale £1347-£1521 per annum including London Weighing. Aged 21 years and over.

Application form (s.a.e.) from Director of Educational Services, Town Hall, Friern Barnet, N11 3DL (Ref: ADM/5/572).
R. H. WILLIAMS,
Chief Executive and
Town Clerk.

PLYMOUTH POLYTECHNIC School of Environmental Sciences

Senior Technician (T3)

required to take charge of the technical services of the Cell Biology section which comprises laboratories covering microbiology, biochemistry, virology, parasitology, cytology and genetics. Qualifications: H.N.C. (A1 year access) or equivalent, with considerable experience in one relevant area and some knowledge of one or more of the other subjects mentioned above.

Salary £4146-£4644 (plus additions for certain qualifications).

Application forms and further details may be obtained from the **Establishment Officer, Plymouth Polytechnic, Plymouth, PL4 8AA** to be returned within 10 days of the date of this advert.

HAMPSHIRE AND ISLE OF WIGHT NATURALISTS' TRUST LTD CONSERVATION OFFICER

Applications are invited for the post of Conservation Officer. Candidates should have practical experience of conservation work, a sound knowledge of ecology, and organising ability. Salary in the range £1500-£2000 according to experience and qualifications. Further particulars may be obtained from the Secretary, King John's Lodge, Romsey, SO5 8BT, to whom applications should be sent, together with curriculum vitae and the names and addresses of three referees, to arrive by 1 March, 1974.

CARDIOTHORACIC INSTITUTE

(University of London)
2 Beaumont Street,
London, W1N 2DX

TECHNICIAN required for interesting research project involving large animals. Applicants should be interested in cardiovascular physiology, immunology and heart transplantation. Previous experience in this field an asset. Appointment for maximum of three years in first instance. Salary not less than £1566 p.a. Application forms available from the House Secretary.

Find your place in British Gas

MICROBIOLOGIST

The British Gas London Research Station are looking for a microbiologist to join a small team concerned with microbiological problems which affect the Gas Industry.

Our work includes long-term research into effects of soil micro-organisms on buried pipes and plastics, and on growth of micro-organisms on hydrocarbon substrates.

Applicants should possess a degree in microbiology or an equivalent technical qualification; experience in industry or hospital work would be an added advantage.

Starting salary will be according to age and qualifications and will be on a scale rising to £2661, £3192 or £3510. Good promotion prospects and conditions of service.

For further information and an application form, write to Research Secretary, British Gas, London Research Station, Michael Road, Fulham SW6 2AD, quoting ref.: 4006/23/NS.

BRITISH GAS



Wellcome

Young Chemist or Biology Graduate for Scientific Information Work

The Wellcome Foundation is a £multi-million international organisation with extensive interests in human and veterinary medicines, pest control and hygiene.

We are looking for a young chemist or biologist to work, as a scientific officer in the Patents and Agreements Department at our London Head Office, on the planning and implementation of procedures and information systems. This position would suit someone, possibly with a library background, who wishes to gain experience in information systems.

Conditions of employment are attractive and include 4 weeks' holiday and assistance with relocation expenses, where appropriate.

Please write to or telephone, quoting reference AQ.97

Mrs. G. Smith, Personnel Officer,
The Wellcome Foundation Ltd,
183 Euston Road, London NW1 2BP
Tel: 01-387 4477



LIVERPOOL POLYTECHNIC

Department of Chemistry RESEARCH ASSISTANT

Applications are invited for this post, to study the composition and biodegradation of mycelial waste from industrial fermentations. The successful applicant will be expected to register for a higher degree and should therefore have a first or second class honours degree (or equivalent) in Chemistry, Biology or a related discipline.

RESEARCH ASSISTANT

Applications are invited for this post, to investigate the structure and fungicidal properties of some novel thio-organometallic complexes. The successful applicant will be expected to register for a higher degree and should have either a Grad. A.R.C. or a first or second class honours degree (or equivalent) in Chemistry.

Department of Electrical and Control Engineering RESEARCH ASSISTANT

Applications are invited for appointment of research assistant having a degree or equivalent qualification in Electrical or Electronic Engineering, to undertake research in one of the following fields:

1. Adaptive Control Systems, both Analog (I.C.) and on-line digital.
2. Generation and analysis of ultrasonic holograms.

The successful applicant will be expected to register for a higher degree. Salary A.P.I. £1,353 - £1,644 p.a.
DETAILS AVAILABLE FROM STAFF OFFICE, DEPT. 'N.S.', LIVERPOOL POLYTECHNIC, RICHMOND HOUSE, RUMFOLD PLACE, LIVERPOOL L5 9AH.

OPPORTUNITIES IN PACKAGING

TWO RECENT GRADUATES OR EQUIVALENT

are required for

1. Development work involving the effective use of a woodpulp based product in packaging applications.
2. Development of test procedures for unit loads, in particular, with vibration effects of transport systems.

PIRA Packaging Division is one of the three leading research institutions in the world dealing with packaging problems. These posts offer a thorough foundation in packaging techniques which could lead to a career in an expanding field. Salary between £1500 and £2500, depending on age, qualifications, etc. Superannuation Scheme. Application forms from the Secretary, PIRA, Randalls Road, Leatherhead, Surrey, quoting reference PAC/DEV/174.

ROYAL FREE HOSPITAL

Dept. of Chemical Pathology

There is a research vacancy for a graduate to work on a project involving bone tissue culture and radio-immune assay techniques. The appointment is to be made as soon as possible.

Salary scale £1824-£2517 plus £126 London Weighting.

Apply in writing to: Dr M. B. Wills, Dept of Chemical Pathology, Royal Free Hospital, Grays Inn Road, London, W.C1.

THE WORKERS' EDUCATIONAL ASSOCIATION
NORTH OF SCOTLAND DISTRICT

WILL APPOINT A

TUTOR ORGANISER

Applicants must possess a degree in subjects suitable for the teaching of Liberal Adult Education. The post is pensionable and the salary scale ranges from £1650 to £3138 with placing according to qualifications. Requests for application forms should be made to: The District Secretary, W.E.A. Office, 480 Union Street, Aberdeen, AB1 1TS.

STANDARDS LABORATORY
FOR SEROLOGICAL
REAGENTS

TECHNICIAN AIMLT

(Bacteriology or Virology) or HNC in Medical Laboratory Sciences (Microbiology) required for work with viral diagnostic reagents. Graduates may apply for this position. Written applications with full details of age, experience and qualifications to the Personnel Officer, Central Public Health Laboratory, Colindale Avenue, London NW9 5HT.



TRUMAN BREWERY

Laboratory Technician

We have a vacancy for a Laboratory Technician in our Research and Development Laboratory.

Applicants should have 4 G.C.E. 'O' levels including Maths, English and Chemistry. Preferred age 18 to 22. Salary according to age and experience.

5 day week, 9-5. Subsidised canteen. Close to Liverpool Street or Aldgate East Stations.

Applications to:

*The Employment Officer,
Truman Limited,
91, Brick Lane, London, E1 6QN.*

NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING SCOTTISH STATION CONTROL OF FIELD MACHINES (Ref. E/2)

Applications are invited for the post of

HIGHER SCIENTIFIC OFFICER

in a small team concerned with the use of automatic and other controls to improve field machine performance. Candidates should have a post degree, HNC, HND or equivalent in engineering or physics and, normally, at least five years' post-qualification experience.

Salary £2,076 to £2,667 p.a. Contributory superannuation scheme, with a non-pensionable allowance of 5% gross salary to offset contributions.

Further particulars from the Secretary, N.I.A.E. Scottish Station, Bunk Estate, Penicuik, Midlothian, EH26 0PN, to whom applications should be returned by 20th February, 1974.

THE UNIVERSITY OF LANCASTER

Applications are invited from suitably qualified persons for the post of LECTURER in ATMOSPHERIC CHEMISTRY in the Department of Environmental Sciences.

The successful candidate will be expected to develop research programmes in atmospheric pollution and related topics. Experience in meteorology would be an advantage but is not essential.

Further particulars may be obtained quoting reference LS 796 from the Establishment Officer, University House, Bailrigg, Lancaster, LA1 4YW to whom applications (five copies), naming three referees, should be sent not later than 28 February 1974.

UNIVERSITY OF LEICESTER SENIOR LECTURER IN BIOCHEMISTRY

Applications are invited for the post of SENIOR LECTURER in the Department of Biochemistry. (Head of Department, Professor H. L. Kornberg, F.R.S.) This is a new post consequent upon the foundation of a Medical School at the University, and the person appointed will be concerned with teaching in the Faculty of Medicine and the Faculty of Science.

Initial salary, dependent on qualifications and experience, within the scale £4,568-£5,486 a year, with F.S.S.U. membership.

Further particulars from the Registrar, to whom applications should be sent by 4th March.

Senior Laboratory Technicians

A vacancy has arisen within our expanding Quality Control Laboratory for a Senior Laboratory Technician. Candidates should have at least H.N.C. in Chemistry and experience of routine chemical analysis, preferably within the Pharmaceutical and Dairy Industry. The post calls for shift work on a routine basis to cover from 6a.m. to 2p.m., 2p.m. to 10p.m. and from 10p.m. to 6a.m.

The above hours will be worked on a 5 day Monday/Friday basis. Candidates must have a high degree of initiative and be able to take responsibility entrusted to him.

Please apply to:

Director of Personnel and Industrial Relations,
John Wyeth & Brother Limited,
Huntermcombe Lane South,
Taplow,
Maidenhead, Berks.
or telephone Slough 28311



ROTHAMSTED EXPERIMENTAL STATION HARPENDEN, HERTS. AL5 2JQ

Applications are invited from suitably qualified scientists for the post of

HEAD OF THE PHYSICS DEPARTMENT

to succeed Dr. H. L. Penman, FRS, who retires on March 31st 1974. The Scientist appointed will be expected to develop lines of research relevant to agricultural physics, and more generally to provide scientific leadership to members of the Physics Department. It is hoped that the new Head will develop additional research programmes in soil physics.

Appointment in the grade of SPSO (£5,550-£6,460). Superannuation under FSSU with a non-pensionable allowance of 4% of basic salary to offset personal contributions.

Applications, giving full details of career and naming two referees and quoting Reference 218 to the Secretary by 1st March, 1974.

LONDON BOROUGH OF HARINGEY

Tottenham College of
Technology, High Road,
London N15 4RU
Telephone: 01-802 3111
Principal: F. C. Thurling,
B.A. (Hons), A.C.I.S., F.R.S.A.
PHYSICS TECHNICIAN
(Grade T.2)

required for work in the laboratories of the Department of Public Health and Science, which offers courses for Public Health Inspector's Diploma, G.C.E. A Level, O.N.C. O.N.D. and C. & G. certificates. The successful candidate will continue or commence studies for appropriate qualifications.

Salary: (Grade T.2) £1242-£1416 per annum plus £105 London Weighting.

Application forms from the Principal, returnable within 14 days of the advertisement.

CHELSEA COLLEGE

University of London TELEVISION TECHNICIAN

A Television Technician (Grade 4) is required to operate and maintain C.T.V. equipment used in the Educational fields. Besides being able to demonstrate technical skills the successful candidate will be expected to work closely with academic staff and students and assist in the interpretation of their requirements in television terms. The ability to record educational material without supervision is an essential requirement. Salary Scale: £2025-£2358 per annum (including London Allowance). Application forms from the Secretary, (NS31/1), Chelsea College, Manresa Road, London, SW6 6LX.

MOUNT VERNON HOSPITAL NORTHWOOD, MIDDLESEX

Northwood 26111

TECHNICAL ASSISTANT

in new Regional Burns Centre to join research team of 8 persons for 3 year project to evaluate new methods in the management of burnt patients. Laboratory, intensive care nursing, or patient monitoring experience would be advantageous. Salary scale £1335-£2154 p.a.

Applications with details of previous experience and the names of two referees should be sent to Mr. R. Sanders, Plastic Surgery Centre, Mount Vernon Hospital, Northwood, Middx.

INTERNATIONAL ABSTRACTS OF BIOLOGICAL SCIENCES EDITORIAL AND INDEXING ASSISTANTS

are required immediately to work on the above journal. The posts would suit recent graduates who should have degree either in Biology or Microbiology. Candidates with a general Biology degree who have some knowledge of Microbiology will also be considered. Offices in pleasant surroundings on the outskirts of Oxford. Further details and an application form may be obtained from Dr. S. D. Thornton, Executive Editor, IABS, Headington Hill Hall, Oxford OX3 0BJ, Tel. Oxford 64768.

KENYATTA UNIVERSITY COLLEGE PROFESSOR IN BOTANY

Applicants should be holders of a Ph.D. degree and must have extensive and proven experience in teaching and research at University level. Ability and enthusiasm to plan, initiate and direct research as well as ability to plan and execute new teaching programmes for both graduates and undergraduates are essential qualifications.

SENIOR LECTURESHIPS/ LECTURESHIPS

Applicants should be holders of a Ph.D. degree in the relevant fields. Applicants for Senior Lectureships should have considerable experience in teaching and research at University level whereas it will be an advantage for applicants of Lectureships.

SENIOR LECTURESHIPS

Physics, Chemistry, Mathematics, Botany and Zoology.

LECTURESHIPS

Physics, Chemistry, Mathematics, Botany (Genetics or Terrestrial Ecology), Zoology (Parasitology or Comparative Anatomy and History or Development Biology or Microbiology).

Kenya University College is basically a teacher training institution and therefore experience in teacher training at University level, will be an added advantage to applicants for all the posts.

Terms of Service include subsidised housing, membership of non-contributory medical scheme and some College contribution towards F.P.S.U. or payment of gratuity at expiry of contract. Expatriate appointments are on tours, each of two years, renewable and include passages for up to 5 adults on appointment, and return tour and on expiry of contracts.

Salary Scales: Professor: KSh6000 + £156-KSh4380 per annum
Lecturer: KSh2556 + £108-KSh2904 + £132-KSh36 per annum.
Lecturers: KSh1900 + £84-KSh2256 + £104-KSh2500 per annum.

Applicants should give names and addresses of three academic referees and at the same time ask them to send their references direct to the Registrar without delay.

Written applications (SDX COPIES) giving full details of Curriculum Vitae including fields of specialisation, age, present post, marital status etc. etc. should be addressed to:

The Registrar, Kenyatta University College, P.O. Box 43844, NAIROBI, Kenya, to reach him not later than 28th February, 1974.

All the above posts are for the 1974/75 academic year which begins on 1st July, 1974.

THE MALAYSIAN RUBBER PRODUCERS' RESEARCH ASSOCIATION

requires an experienced
**ELECTRON MICROSCOPE
TECHNICIAN**

to take charge of the operation and maintenance of its Siemens Elmiskop Mk 1 and ancillary equipment. The post is suitable for candidates aged between 25 and 35 with experience in biological and physical work and with a good knowledge of repair, embedding and sectioning techniques. The starting salary may be between £1400 and £1600 per annum, depending on age, experience and qualifications. There is a pension scheme.

The Association will be moving in mid-1974 to an attractive new location on a 20-acre site near Herford. Transport from Welwyn Garden City and locality may be provided.

Please write giving details of qualifications and experience to:

The Director,
The Malaysian Rubber Producers' Research Association,
54 Tewin Road,
Welwyn Garden City,
Herts.

RESEARCH OPPORTUNITIES IN LABORATORIES



Applications are invited for the following positions which are available in the Scientific Services Department of the North Western Region of the Central Electricity Generating Board. The Departmental Laboratories are located in Wythenshawe, South Manchester.

RESEARCH OFFICER (Vacancy No. 509/NS)

A metallurgist is required with specific experience and proven ability in the field of service failure investigations related to engineering components; he would also be expected to be fully conversant with developments in aspects of metallurgy and materials science relevant to the Power industry.

The successful candidate will occupy the senior position in a group of metallurgists within the Field Services Section and will accordingly have demonstrated that he possesses the necessary qualities of leadership. The post will involve close liaison with all levels of staff at Power Stations and Electrical Districts in the North Western Region.

A good honours degree in metallurgy is the minimum academic qualification required together with at least five years relevant experience.

Salary will be within the range £2919 - £3864 per annum or £3738 - £4656 per annum depending on qualifications and experience.

RESEARCH OFFICER (Vacancy No. 510/NS)

is required in the Non-Destructive Testing Applications Centre. The successful candidate will be part of a group providing a specialist service to the Region applying fracture mechanics to the assessment of the significance of defects in plant.

Applicants should have a good honours degree in metallurgy and experience in the application of fracture mechanics techniques to failure prediction. Research experience will be an advantage.

Salary will be within the range £1732 - £2655 per annum or £2571 - £3204 per annum depending on qualifications and experience.

RESEARCH OFFICERS (Vacancy No. 511/NS)

Two process control engineers are required for an expanding control group in the Electrical Engineering Section. A knowledge of modern control theory is necessary, and experience of continuous process industrial plant would be an advantage. The work entails the automation of older power stations and the post-commissioning of modern power stations, together with basic control and automation research projects.

A good honours degree or equivalent is required.

Salary will be within the range £1632 - £2655 per annum or £2571 - £3204 per annum or £2919 - £3864 per annum depending on qualifications and experience.

Applications to be on the Board's standard application form obtainable from the Personnel Manager, CENTRAL ELECTRICITY GENERATING BOARD, 825 Wilmslow Road, East Didsbury, Manchester M20 8RU to be returned not later than 15th February 1974. Please quote the appropriate vacancy number.

AGRICULTURAL RESEARCH COUNCIL APPOINTMENT OF FOUR SCIENTIFIC ADVISERS

The Agricultural Research Council invites applications for four posts, at its Headquarters Office in London, for Scientific Advisers to the Secretary of the Council, concerned with (a) food science and (b) plant sciences (5 posts).

A good background of scientific studies and a proved record in research will be required. In addition, applicants should have studies in depth one or more specialised fields related to the scope of their duties, preferably the following:

- (a) Scientific Adviser (Food Science) Microbiology.
- (b) Scientific Advisers (Plant Sciences). 1. Plant biochemistry/Cell biology. 2. Genetics and Plant Breeding. 3. Crop protection (Entomology; Plant Pathology).

Advisers are expected to aid in the formulation of agricultural research programmes and in their execution, and to assist in the staffing and equipping of Agricultural Research Institutes and Units. They are required to assist in the work of the Council and its Committees, to represent the Council and also with that of the Research Boards and Committees set up jointly by the Council, the Ministry of Agriculture Fisheries and Food and Department of Agriculture and Fisheries for Scotland, by providing them with information and technical servicing. They have to establish and maintain particularly working relationships with the Directors and scientific staff of the Research Institutes, Units and also with other organisations concerned with agricultural research and development, and to liaise with scientists in the agricultural departments. In addition to scientific expertise the work calls for the ability to express ideas clearly both orally and in writing.

The appointments will be at the level of Senior Principal Scientific Officer £5745-£6635 per annum according to experience. The salary scale, which is under review, is inclusive of Inner London Weighting, Superannuation under Civil Service type arrangements.

Further particulars about the post and the range of duties are available from the Secretary, Establishment Officer, Agricultural Research Council, 166 Great Portland Street, London, W1N 6DT to whom applications should be sent by 22nd February 1974.

ROYAL POSTGRADUATE MEDICAL SCHOOL

(Hammersmith Hospital)
Department of Haematology

Applications are invited for the following posts:—

1. **TECHNICIAN** in blood transfusion department. The range of application of routine tests and specialised work is carried on, providing excellent opportunities for research. Advanced blood transfusion exam of the IMLT. Ref. 7/114/NS.

2. **TECHNICIAN** in haematology department. The range of work gives opportunity to gain wide experience in all the aspects of haematology required for the advanced exam of the IMLT. Ref. 7/111/NS.

3. **TECHNICIAN / GRADUATE** TECHNICAL OFFICER required to work on development and routine aspects of quality control in haematology. Ref. 7/269/NS.

4. **TECHNICIAN** with training in electron microscopy required for haematology quality control project. Ref. 7/228/NS.

Classes for advanced exams are held at the School. The salary and grading for these appointments will be according to qualifications and experience.

Applications to the Secretary, R.P.M.S. Hammersmith Hospital, DuCane Road, London, W6 0HS, quoting the appropriate Ref.



LONDON BOROUGH OF BARNET

Education Department

SENIOR LABORATORY TECHNICIAN

qualified and experienced required as soon as possible to take charge of 6 laboratories (4 new) and 2 preparation rooms, at Edgware School, Green Lane, Edgware. The School courses lead to 'A' level examinations in Biology, Chemistry and Physics. The successful candidate will be responsible for the maintenance of and maintenance of all stock, apparatus and equipment and the supervision of laboratory technicians. Five day, 36-hour week. Permanent superannuation post. Commencing salary within Technician Grade 5, range £1521-£1749 p.a. per annum including London Weighting, plus up to £1000 p.a. per annum qualification allowance in appropriate cases.

Apply in the first instance to the Headmaster (Tel: 01-558 5310). LABORATORY TECHNICIAN

with particular interest in physical sciences, to undertake part-time duties, up to 28 hours each week at QUEEN ELIZABETH'S GIRLS' School, High Street, Barnet. Varied and interesting work as well as routine tasks in six good laboratories, preparation rooms and work rooms. Duties include assisting with assembly, care and maintenance of apparatus, preparation of equipment, use of chemicals etc. Salary pro rata to the full-time Technician 2 Scale £1347-£1521 p.a. per annum including London Weighting. Additional payment for recognised qualifications.

Apply Immediately to Headmaster stating qualifications and experience and giving names of two referees and enclosing recent test certificates, if any.

B. H. WILLIAMS
Chief Executive and Town Clerk

UNIVERSITY OF READING

Department of Applied Physical Sciences

RESEARCH ASSISTANT

A Research Assistant is required to work for a period of years under the supervision of Dr. A. J. Pretlove on work sponsored by the Science Research Council entitled "The effects of defects on glass damage". The work is principally directed towards a study of mechanical damage to window glass. Applicants should possess a good degree or higher degree or a higher degree and should be familiar with both the mechanical properties of materials and dynamics. The starting salary will be in the range £1700 to £2100 p.a. In applications, give details of curriculum vitae and the names of two referees, should be sent, quoting Ref: MUG/24, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading, RG6 2AH.

THE LONDON HOSPITAL MEDICAL COLLEGE

(University of London)

RESEARCH ASSISTANT—GASTROENTEROLOGY

Applications are invited for the appointment of Research Assistant within the Medical Unit. Duties will involve the study of pancreatic function and the post would be suitable for a graduate holding a good honours degree with a special subject in either Physiology or Biochemistry. Opportunities to study under higher qualification within the range £1563/£1722 plus £162 London Allowance per annum. Applications giving full details of education and qualifications, together with name of referee, to: The Secretary, The London Hospital Medical College, Turner Street, London, E1 2AD, quoting Ref: MUG/24.

UNIVERSITY OF MALAWI

BUNDA COLLEGE OF AGRICULTURE

Applications are invited for the following posts tenable from 1 September 1974 for staff to teach at both degree and diploma levels:

1. Professor/Senior Lecturer in AGRICULTURAL ECONOMICS in the Rural Development Department

Applicants should have a higher degree in Agricultural Economics and at least five years' teaching and research experience in the fields of the rural development, economics, marketing and farm management economics. The post carries with it the headship of the Rural Development Department which is responsible for teaching and research in Economics, Farm Management, Extension, Rural Sociology, Home Economics, Human Nutrition and Communication. Some administrative experience and a genuine interest in integrated rural development are desirable. Experience in socio-economic research for rural development would be an advantage.

2. Lecturer/Assistant Lecturer in AGRICULTURAL ECONOMICS in the Rural Development Department

Applicants should have a good honours degree in Agriculture or Economics with a higher degree or postgraduate qualifications and experience in Agricultural Economics. A strong interest and/or experience in integrated rural development is desirable.

3. Senior Lecturer/Lecturer in AGRICULTURAL EXTENSION in the Rural Development Department

Applicants should have a good honours degree in Agriculture and a higher degree or postgraduate qualification and experience in Agricultural Extension. Interest in the development of Extension Methods and the use of integrated rural development is desirable. Experience in agricultural extension in a developing country would be an advantage.

4. Professor/Senior Lecturer in LIVESTOCK PRODUCTION in the Livestock Production Department

Applicants should have a higher degree in Agriculture, Animal Science or Veterinary Science and at least five years' teaching and research experience in one or more of the following areas: nutrition, physiology, pasture production and management, livestock production systems. The post carries with it the headship of the Livestock Production Department and thus some administrative experience and a genuine interest in aiding the development of the livestock industry in Malawi is desirable.

5. Lecturer in LIVESTOCK PRODUCTION (2 posts) in the Livestock Production Department

Applicants should have a higher degree in Agriculture, Animal Science or Veterinary Science and teaching experience in one or more of the following areas: nutrition, physiology, pasture production and management, livestock production systems. The ability to teach vertebrate biology as applied to agriculture would be an advantage.

6. Lecturer/Assistant Lecturer in AGRICULTURAL CHEMISTRY/BIO-CHEMISTRY in the Livestock Production Department

Applicants should have a good honours degree in Agricultural Chemistry/Biochemistry and appropriate postgraduate qualifications and experience. Ability to teach and research in some aspects of nutrition or physiology would be an advantage.

7. Lecturer/Assistant Lecturer in PLANT PATHOLOGY in the Crop Production Department

Applicants should have a good honours degree in the Biological Sciences or Agriculture and postgraduate qualifications and experience in plant pathology. The successful candidate will teach Plant Pathology as part of the Crop Production course and Agricultural Biology and also develop practical research in Plant Pathology.

8. Lecturer/Assistant Lecturer in HORTICULTURE in the Crop Production Department

Applicants should have a good degree in Horticulture or Agriculture with postgraduate training and/or experience in Horticulture. Duties of the post include teaching horticultural subjects, the development of a fruit and vegetable demonstration unit at the College Farm and the initiation and development of practical research in horticulture relevant to the needs of Malawi.

Salary scales (including emoluments): Professor £2,900-£3,700 p.a. Senior Lecturer £2,500-£2,800 p.a. Lecturer £1,360-£1,600 p.a. Assistant Lecturer £950-£1,280 p.a. plus either a University endowment of £200 p.a. for Assistant Lecturers, £360 p.a. for Lecturers, £500 p.a. for Senior Lecturers or £680 p.a. for Professors (taxable in Malawi) or supplementation (normally tax free) in appropriate cases by the British Government, in range £800-£1,380 p.a. (if married) or £200-£1,100 p.a. (if single). This latter supplementation is unlikely to be applied to appointments as Assistant Lecturer level. The British Government may also provide children's education allowances and holiday visit passages. Gratuity; superannuation scheme transferable with FSSU; family allowances; biennial overseas leave. Detailed applications (2 copies) including a curriculum vitae and naming 3 referees, should be forwarded to the Registrar, University of Malawi, P.O. Box 278, Zomba, Malawi. Applicants resident in UK should send 1 copy of University of Malawi Council, 90/91 Tottenham Court Road, London W1P 0DT. Further particulars of the appointments are obtainable from either address.

PHYSICIST or ELECTRICAL ENGINEER required for the development and application of electro-physiological techniques in the diagnosis of central disorders of hearing. Good knowledge of electro-physiological techniques essential. Salary in accordance with age and qualifications. Full superannuation. Applications to The Director, MRC Hearing and Balance Unit, Institute of Neurology, National Hospital, Queen Square, London, WC1N 3BG.

JUNIOR TECHNICIAN GRADE A OR B. The Department of Virology at St. George's Hospital Medical School, Hyde Park Corner, S.W.1, requires a technician to work on the routine virology diagnostic laboratory. Whitley Council salary scale. Applications with the names and addresses of two referees should be made to Professor H. Stern at the above address.

THE UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY

Applications are invited for the post of
AUDIO VISUAL TECHNICIAN
(Ref: CEM/15/AJ)

The successful candidate will work in a newly established centre, which will be utilised in the fields of academic and technical staff of the Institute in the educational uses and operations of audio visual material. He or she will be expected to assist in the preparation of audio visual material and in maintenance of equipment. The post will require expert knowledge of the full range of audio visual equipment and methods, and also an ability to cooperate with the staff of the Institute and the Audio-Visual Service of Manchester University.

Applicants must be educated to at least O.N.C. standard or its equivalent and show evidence of recognised training in some aspects of audio visual presentation. A knowledge of photography, production techniques and educational uses of television is desirable in the successful candidate, who should have had at least six years of appropriate experience in industry or education. Salary scale Technician Grade 5: £2007-£2382 p.a.

Requests for Application form, quoting Reference No. CEM/15/AJ, should be sent to the Registrar, U.M.I.S.T., Sackville Street, Manchester M1 1QJ.

Closing date for applications—28th February, 1974.

THE UNIVERSITY OF LEEDS

Department of Mechanical Engineering

Applications are invited for the post of **RESEARCH ENGINEER** from graduates with a first class degree or equivalent in engineering or mathematics and an interest in the design of mechanical systems. The project is directed towards finding an engineering solution to the control of flexible space vehicles. An important part of the work will be the review and critical assessment of control and simulation techniques and hybrid computation will play a significant role in the project. The salary is available for a period of two years and is financed by the Science Research Council. Salary in the scale £2058-£2223, (with FSSU). Terms of application and further particulars from the Registrar, The University, Leeds LS2 9JT (please quote LS2/24/ET). Closing date 4 March 1974.

TOP GRADE BIOCHEMIST/CONSULTANT CHEMICAL PATHOLOGIST

The Wessex Regional Hospital Board requires a Top Grade Biochemist or Clinical Chemical Pathologist for the Clinical Pathology Area to take charge of the Clinical Chemistry Service and develop a new, highly specialised clinical chemistry laboratory in the new Basingstoke District General Hospital.

A suitable candidate will be offered an Honorary Senior Lectureship in Chemical Pathology at the University of Southampton. Duties will include two sessions per week in Southampton for teaching and research.

Application forms and job descriptions available from the Senior Administrative Officer, Hants. Highcroft, Romsey Road, Winchester, Hants. Please quote reference 630.

Closing date: 21 February, 1974.

UNIVERSITY OF SOUTHAMPTON

Department of Aeronautics and Astronautics
RESEARCH ASSISTANT/
STUDENT

Applications are invited for the post of Research Assistant/Student for work on the dynamic stability of axisymmetric bodies at high Mach numbers. The work involves the development of a new type of aerodynamic facility and the exploitation of existing equipment for the measurement of dynamic stability derivatives.

Applicants should possess a good honours degree, or the equivalent, in a subject relevant to this research. The salary will depend on qualifications and experience and, in the case of a Research Assistant, will not exceed £150 per annum. The successful applicant will be expected to register for a higher degree.

Applications, including the names and addresses of two referees, should be addressed to The Deputy Secretary's Section, The University, Southampton, SO9 5NH as soon as possible. Please quote reference number: NS182/R.

CRANFIELD

Department of Materials

Applications are invited from suitably qualified graduates for appointment as
LECTURER IN
POLYMER ENGINEERING

The successful candidate will be required to expand post-graduate teaching and research programmes in the field of plastic processing, with particular reference to the influence of processing upon mechanical properties and will be expected to work closely with industry in developing these programmes.

Candidates should preferably be physicists, engineers or materials scientists with several years of relevant postgraduate research and/or development experience in industry.

Starting salary in the Lecturer range: £1929 to £4548, with FSSU.

Further particulars and forms of application can be obtained from The Secretary (Appointments), Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL, quoting reference 190P.

ST. BARTHOLOMEW'S HOSPITAL, London E.C.1.

Applications are invited for the post of Research Assistant in the Radio-Isotope Department at St. Bartholomew's Hospital. Duties will involve investigations into kidney disease.

Qualifications: ONC, BSc (previous experience not essential); alternatively 2 'A' levels in scientific subjects with 3 years relevant experience. Salary according to qualifications and experience, within the range £1454-£1605 (including London Weighting). Applications in writing, to Personnel Officer quoting Ref: R/4614/NS.

THE UNIVERSITY OF MANCHESTER

There is a vacancy for a Technician in the Electron Microscope Unit of the Botany and Zoology Departments. Applicants should have at least an ONC or equivalent qualification and preferably H.N.C. and have had 6 years relevant experience including ultramicroscopy and other preparatory techniques. Salary scale £1454-£2186.

Applications with full details of age, qualifications and previous experience should be sent to Dr. E. Butler, Department of Botany, The University, Manchester M13 9PL as soon as possible.



BUSINESS ANALYSIS

Scientific and Technical Intelligence Officer

required for the commercial planning and intelligence department within group strategy office of BOC

THE JOB

- to maintain a wide awareness of all branches of applied science and technology
- to analyse specific areas on a techno-commercial basis as an aid to identifying potential new business areas for BOC.

APPLICANTS (MALE OR FEMALE)

- should be aged 25-32.
- have a natural sciences or engineering degree. Minimum Hons. II, but preferably a higher degree with a technological bias rather than pure sciences.
- have at least three years' relevant post graduate experience in industry.
- show an interest in business and current technology.

SALARY

- negotiable around £2600.

Please write, with details, to:

Carol Ansell, Assistant Personnel Officer,
British Oxygen Company Limited,
Hammersmith House, London W6 9DX.

MEDICAL RESEARCH COUNCIL

NATIONAL INSTITUTE FOR MEDICAL RESEARCH Nuclear Magnetic Resonance Spectroscopy Laboratory

Applications are invited for a research assistant to work in the Nuclear Magnetic Resonance Spectroscopy laboratory of the Division of Molecular Pharmacology using Varian XL 100 and HA 100 spectrometers equipped with Fourier transform and computing facilities. The applicant should be preferably of graduate standard and have a background in Chemistry, Physics or Computing. Experience in using analytical equipment or machine language programming would be an advantage. Salary according to age and experience within the scales £1533 - £2189 p.a. and £2310 - £3183 p.a. Please write with brief details of age, qualifications, and experience quoting ref: T01MP to J. H. Woodcock, Personnel Officer, National Institute for Medical Research, The Ridgeway, Mill Hill, NW7 1AA (Tel: 01-858-3866).

UNIVERSITY OF OXFORD

Department of Metallurgy and Science of Materials

Applications are invited for the post of Research Assistant to join a group working in the field of solidification and specifically on a project concerned with macro segregation in castings and ingots. The post is available for two years in the first instance.

Candidates should possess a Ph.D. degree or equivalent. Previous research in solidification or experience in industry would be an advantage. Salary range £1919 (age 24) to £2718 (age 29).

Applications including a brief curriculum vitae should be sent to the Administrator, Department of Metallurgy and Science of Materials, University of Oxford, Parks Road, Oxford OX1 3PH.

UNIVERSITY OF OXFORD

Department of Biochemistry
Genetics Laboratory

It is proposed to appoint a Departmental Demonstrator in Genetics from 1 October next. The salary to be up to £2283 per annum according to qualifications and experience, together with membership of FSSU (or equivalent—under review). The appointment is for a period not exceeding three years in the first instance and may be renewable for a further period up to a total of six years.

Other things being equal, preference may be given to candidates working in, or interested in working in, the field of the genetics and biochemistry of animal cells.

The successful candidate will be expected to take part in Departmental teaching and to conduct his own research.

Applications (three copies) including the names of two referees should be sent to the Administrator, Department of Biochemistry, University of Oxford, South Parks Road, Oxford, not later than 11 March, 1974.

UNIVERSITY OF SOUTHAMPTON

Department of Chemistry
TECHNICIAN GRADE 4

is required in the Analytical Group of the Chemistry Department for work in elemental analysis using atomic absorption spectroscopy both by applications of existing methods and by development of new methods.

Applicants should possess ONC, two 'A' levels or equivalent qualification and have experience of practical analytical chemistry.

The appointment is established with a starting salary of £1848-£2163 depending upon qualifications and experience.

Applications should give age, qualifications and experience and the names and addresses of two referees, should be sent to the Deputy Secretary's Section (Ext. 2400), The University, Southampton, SO9 5NH, as soon as possible. Please quote reference number: NS165/T.

EDITORIAL ASSISTANT

required for instrument physics journal. Candidates should have degree qualifications in physics or a related subject, but previous editorial experience is not required. Starting salary at least £1440 per annum.

Further details and application forms from—

The Executive Editor
Institute of Physics
1 Lower Gardens
Prince Consort Road
London SW7 2BZ
Tel: 588-0045

PRESTON EDUCATION COMMITTEE

Preston Polytechnic
RESEARCH TECHNICIAN

T4 salary scale £1644 to £1926 p.a. with additional £42 or £72 per annum for O.N.C. or H.N.C. or acceptable equivalent, 37 hour week. Post superannuable.

Applicant required with sufficient ability in structural materials to maintain and build equipment in the physics research laboratories. Participation in experimental work will be encouraged.

Details and application form from the Preston Polytechnic, Corporation Street, Preston, PR1 2QU. Closing date 8th February, 1974.

THE OPEN UNIVERSITY FACULTY OF TECHNOLOGY FACULTY EDITOR OR ASSISTANT FACULTY EDITOR

The Assistant Faculty Editor will work on student correspondence texts (Course Units), student assignments and other related material prepared by the Faculty of Technology, in the fields of design, electronics, engineering mechanics, materials science and systems. Duties will include editing, proof-reading, liaison with the University production departments and work on all printed material at each stage of production. Several years' experience of scientific or technical editing is essential.

Salary on scale: £1756-£3378 per annum according to age and experience.

Requests (on postcards) for application forms and further particulars should be sent to the Acting Personnel Manager (ETI) The Open University, P.O. Box 75, Walton Hall, Milton Keynes, MK7 6AL. Applications should be returned by Friday, 8th February, 1974.

TECHNICON METHODS AND STANDARDS LABORATORY

54-58 Bartholomew Close, London EC1

Invite applications from Biochemists holding a PhD or good honours degree for a range of positions in this newly founded research laboratory.

The laboratory is engaged in the development of new methods and techniques for automation in the fields of immunochemistry, enzymology and biochemistry.

Successful applicants will be encouraged to attend scientific meetings and to publish their work.

We are offering an academic type atmosphere with the conditions of employment, career and salary opportunities one expects from a large international company.

Applications in writing should be sent to the laboratory manager at the above address.

QUEEN ELIZABETH COLLEGE (University of London) Camden Hill Road, W8-7AH RESEARCH TECHNICIAN

Applications are invited to work as one of a research team investigating neutrophil function in leukaemia. A background in the biological sciences required but experience in Haematology, whilst an advantage is not essential. Preference may be given to candidates with a higher degree or alternatively opportunity to work for a higher degree may be provided for suitable candidates.

Welsh National School of Medicine (University of Wales)

Applications are invited for a Scientific Officer in the Department of Haematology to work as one of a research team investigating neutrophil function in leukaemia. A background in the biological sciences required but experience in Haematology, whilst an advantage is not essential. Preference may be given to candidates with a higher degree or alternatively opportunity to work for a higher degree may be provided for suitable candidates.

Salary scale on the Junior Scientific Officer scale £1,380-£2,112 or on the Scientific Officer scale £1,824-£2,517 according to qualifications.

Applications (no forms provided) accompanied by a curriculum vitae and the name and addresses of two referees should reach the Registrar, Welsh National School of Medicine, Health Park, Cardiff, CF4 4XN, by 28th February, 1974.

TECHNICIAN AT THE OPEN UNIVERSITY

The Materials Science and Engineering Mechanical Disciplines of the Faculty of Technology require a Technician to assist the staff of the Faculty in scientific research and laboratory work associated with television, visual aids and kits of experimental apparatus for students' use in their own homes.

Candidates are expected to have an ONC/HNC or equivalent qualification in metallurgy and/or mechanical engineering, with at least four years' experience. Candidates from allied engineering backgrounds will also be considered.

Salary, according to age, experience and qualifications, will be within the scale: £1848-£2163 per annum, with superannuation benefits.

Application forms and further particulars are available from The Acting Personnel Manager, The Open University (EM2), P.O. Box 75, Walton Hall, Milton Keynes, MK7 6AL. Closing date: Monday, 11th February 1974.

THE ANIMAL VIRUS RESEARCH INSTITUTE Pirbright, Woking, Surrey VACCINE RESEARCH DEPARTMENT

Applications are invited for a post in the above Department. The successful candidate will work in a small team on the selection and development of new foot-and-mouth disease vaccine strains. The work will involve the assessment of new strains on the laboratory scale for growth properties and immunogenicity.

Experience in virus work is essential and interests in viral immunology and strain selection procedures would be an advantage.

Applicants should have a good Honours degree in Microbiology or allied subject and some years' experience as a post-graduate research worker. Appointment in S.S.O. grade (£2615-£3640), depending on age and qualifications. Superannuation under F.S.S.U. with allowance to offset cost of contributions. House available for suitable married applicants. Further particulars and application forms from Secretary.

NORTHERN REGIONAL HOSPITAL BOARD (SCOTLAND)

Applications are invited for the newly established post of Basic Grade Biologist (Graduate) in the Pathology Department of the Regional Hospital Board's Laboratories at Inverness. If possible prospective candidates should have special experience in cancer chemotherapy screening and/or tumour immunology. Salary in accordance with Whitley Council agreements.

Further particulars and forms of application are obtainable from the Senior Administrative Medical Officer, Northern Regional Hospital Board, Royal House, 10, Edinburgh Road, Inverness, with whom applications should be lodged by 14th March 1974.

UNIVERSITY OF WARWICK SYSTEMS PROGRAMMER FOR ON-LINE COMPUTER

Applications are invited for the post of Systems Programmer in the Department of Physics. The Department is establishing a new on-line computer facility for the simultaneous control of several research experiments and the selection and evaluation of data from these experiments. The system comprises the new GEC 4080 computer plus Microconsultants' interfacing hardware, provided under a recent SRC award. A systems programmer is required to set up the programming system based on existing manufacturers' software, and assume general responsibility for maintaining and updating the system. The appointment is for three years initially, on the scale £1855-£2535 p.a. with P.S.U. Ideally the applicant should be a graduate with some experience in systems programming. A grounding in the physical sciences would be an advantage. It is hoped to make an appointment by 1st March 1974. Applications in writing (no forms) to the Academic Registrar, University of Warwick, Coventry CV4 7AL, quoting Ref. No: 25/9Q/74 as soon as possible.

NORTHWICK PARK HOSPITAL AND MEDICAL RESEARCH COUNCIL—

Department of Health
Epidemiology and Medical
Care Unit, Harrow

GRADUATE, TECHNICIAN OR JUNIOR TECHNICIAN

required in the joint coagulation laboratory of this large hospital's haematology department and the above Unit. The work consists mainly of estimating the clotting factors and of platelet and fibrinolytic activity in research studies. Successful candidates will be in hospital service. The posts offer an unusually wide range of interesting opportunities in the fields of thrombosis and bleeding disorders, and successful applicants may also spend some time in blood lipid ultracentrifuge work. Previous experience in coagulation desirable.

Salary on the Council's scales, according to qualifications and experience. London Weighting. Superannuation provision. Further details from Dr. T. W. Meade, Director, Epidemiology and Medical Care Unit, Northwick Park Hospital, Watford Road, Harrow, Middlesex, HA1 3UJ.

AUSTRALIAN NATIONAL UNIVERSITY CHAIR OF BIOCHEMISTRY

Applications are invited for appointment to the Chair of Biochemistry in the Faculty of Science. The Chair became vacant in November 1973 when Professor M. Birt resigned to take up the appointment of Vice-Chancellor Designate of Wollongong University College, New South Wales. It is hoped that the appointees will be able to take up duty in 1974.

The Department of Biochemistry offers courses leading to the pass and honours degree of Bachelor of Science and supervises students for the degrees of Master of Science and Doctor of Philosophy. Undergraduate teaching in biochemistry, to a limited extent in microbiology, begins in the second year of the Bachelor of Science course. Seven semester courses at second and third year level are offered. There are seven members of the academic staff (lecturers and above).

The salary for the post is \$A19,102 per annum. The University provides reasonable travel and removal expenses and assistance with housing for an appointee from outside Canberra. Superannuation is on the PSSU pattern with supplementary benefits. Financial assistance towards study leave is also available.

The University reserves the right not to make an appointment or to make an appointment by invitation.

Further information and the forms which should accompany any application may be obtained from the Association of Commonwealth Universities (A.C.U.), 36 Gordon Square, London WC1H 0PF.

Applications close on 25 March 1974.

QUEEN ELIZABETH COLLEGE

(University of London)
Camden Hill Road, W8 7AH
RESEARCH TECHNICIAN
required to operate and maintain Chemistry Department AEI MS 30 Mass Spectrometer. The instrument provides the ULIRS gas chromatography/mass spectrometry service for London University. An AEI DS 50 Data Acquisition System will be added in April.

Applications with the names of two referees and a note of qualifications and any relevant experience to Dr. A. J. MacLeod at the above address.

UNIVERSITY OF WARWICK PROFESSORSHIP OF ENVIRONMENTAL SCIENCES

Applications are invited for a new post of Professorship of Environmental Sciences tenable from 1 October, 1974. Salary in the Professorial range (minimum £5625 p.a.). Superannuation and removal allowance payable. Further particulars may be obtained from the Economic Region of the University of Warwick, Coventry, CV4 7AL, to whom applications (3 copies) naming three referees should be sent by 28 February, 1974. Please quote Ref. No: 26/Q24.

TECHNICIAN in Department of Zoology, University of Reading. Whiteknights, to be responsible for day-to-day running of the electron microscopy laboratory. Qualifications should include recent experience of electron microscope maintenance. Some knowledge of preparative techniques for biological material is desirable. Salary £5067.2325 p.a. (Grade S1). Apply for further particulars, quoting Ref. TS 80, to Assistant Manager (Personnel), University of Reading, Whiteknights, Reading, RG6 2AH.



Wellcome

Young Chemist Pharmaceutical Analysis

The Wellcome Foundation is a £multi-million international pharmaceutical company, with factories and offices on every continent in the world.

Our major UK site is at Dartford, where the Quality Control division is responsible for carrying out total quality control on a wide range of materials and products. We now require a chemist to be responsible for carrying out chemical analysis and physical tests on synthesised intermediates and finished products. Supervision and training of staff is involved.

Candidates should be qualified to degree level and analytical experience would be an advantage.

Salary will depend on qualifications and experience and an attractive fringe benefit package, including generous assistance with relocation expenses where appropriate, is offered.

Please write or telephone for an application form, quoting reference AQ.330, to:

Site Personnel Officer (CS),
The Wellcome Foundation Limited,
Temple Hill,
Dartford, Kent.
Tel: Dartford 23488.



Assistant Librarian

Foster Wheeler Limited, a leading international engineering and process plant contractor to the oil and chemical industries, requires an Assistant Librarian for its expanding Library and Information Service.

We are looking for a Chartered Librarian, preferably with industrial experience, to supervise the day-to-day operations of the library, with particular responsibility for the classification and cataloguing of books, reports and pamphlets, and maintaining collections of British and foreign standards.

The company offers a good salary, commensurate with experience and qualifications. Benefits include a subsidised travel scheme, contributory pension scheme with free life insurance, and an active sports and social club. The company is at present in modern offices near Paddington Station and, later this year, will be moving to new air-conditioned offices in Reading.

Please write or telephone for an application form to: Mr. T. Brown, Personnel Manager, Foster Wheeler Limited, Foster Wheeler House, Chapel Street, London NW1. (Telephone: 01-723 1221, extension 404 or 699).

CITY OF BIRMINGHAM
Public Health Department

SPECIAL DUTIES OFFICER (NOISE)

Interested in helping protect people from noise? The Environmental Protection Unit in the City of Birmingham Public Health Department is establishing a new post of Special Duties Officer (Noise) to control a team dealing with noise monitoring. Problems include noise from road traffic, from aircraft and from industry. Sophisticated noise monitoring equipment has been bought and the officer appointed will control and develop this.

Applicants should have experience of this type of work and preferably possess an appropriate university degree.

Applications with relevant information and names of two referees to the Chief Public Health and Housing Inspector, City of Birmingham Public Health Department, Trefleiger House, Paradise Circus, Queenway, Birmingham B1 2BQ, within 7 days of this advertisement.

This advertisement appears after consultation with the local Government Staff Commission for England who have agreed to the post being advertised nationally. Preference will be given, although preference will be given to local government officers serving in England (excluding London) and Wales.

CHELSEA COLLEGE

University of London
Appointment of
**SUPERINTENDENT OF
LABORATORIES**
(GRADE 8 (1))

Biological Sciences Group
Applications are invited for a new post of Superintendent of Laboratories within the Environmental Federation of the Departments of Applied Biology and Zoology to form the Biological Sciences Group.

The work of the Group covers four main fields of General Biology, Comparative Physiology and Biochemistry, Environmental Biology and Microbiology. The Superintendent will be responsible for all technical services in the Group, including the co-ordination of the work of all the technical staff and the supervision of all teaching and research laboratories, stores, museums, aquarium, culture room, apparatus, vehicles, purchasing and accounts and staff training. He will also play a significant part in the planning of laboratories for the Group in the proposed new campus of the College on a site in the London Borough of Wandsworth. Salary Scale: £3014-£3389 per annum (including London Allowance). Application forms and further details from the Personnel Officer, (INS) Chelsea College, Manresa Road, London, SW10 8LX. Closing date 15th February 1974.

UNIVERSITY OF ASTON IN BIRMINGHAM RESEARCH ASSISTANT

A Research Assistant is required to carry out literature and information surveys involving the collection, compilation and presentation of economic and socio-economic data for research and teaching. A degree or equivalent qualification is required, preferably coupled with some experience in research and information use or library.

Commencing salary will be in the range £1206-£1869 per annum. Requests for further details and application forms (which should be returned within 14 days of the appearance of this advertisement) should be sent to the Personnel Officer, quoting Ref. No. 556/32 to Staff Officer, University of Aston in Birmingham, Gosta Green, Birmingham B4 7ET.

Production Management Trainee

There is a vacancy for a production management trainee at our Havant, Hants, site.

The successful candidate will be a recently qualified pharmacist, and will be intent on making a career in pharmaceutical production management. Initially, he will be involved in production procedures and processes and will be given training and progressive responsibility in preparation for an ultimate management appointment.

This appointment offers good working conditions in modern premises, situated close to the South Coast.

An attractive salary will be paid and the company operates a non-contributory Pension Scheme.

Please apply to:

Director of Personnel & Industrial Relations,
John Wyeth & Brother Limited,
Hintercombe Lane South,
Taplow,
Maidenhead,
Berks.

telephone: Slough 28311



CORPORATE LABORATORY RUNCORN

The Corporate Laboratory has a small number of vacancies for

EXPERIMENTAL PHYSICISTS

With recent PhD or equivalent experience to create and manage research programmes in the Laboratory's Solid State Group. Existing programmes include research into solid state properties of both organic and inorganic materials.

The Laboratory is an interdisciplinary community where scientists have considerable freedom in carrying out exploratory research. Initiative and creativity are therefore the key requirements, and breadth of outlook is more important than specialised experience.

If you are interested in applying, please write giving brief details of experience and age, to:

Mr. J. A. Hurst
Personnel Officer
ICI Limited
Corporate Laboratory
P.O. Box 11
The Heath, RUNCORN
Cheshire WA7 4QE

THE UNIVERSITY OF LANCASTER DEPARTMENT OF ENVIRONMENTAL SCIENCES

Applications are invited for

TWO LECTURESHIPS

In Environmental Sciences, The Department is seeking to strengthen the existing subject areas of geology and hydrology, particularly within the fields of engineering geology and of sedimentary geochemistry. Persons appointed to these posts would be expected to contribute to the Departmental teaching and research programmes in these subject areas. In addition, a contribution to the geomorphological teaching would be a valuable asset. The Department wishes to give more emphasis to applied research topics and it would be expected that the new appointments help expand such activities.

Further particulars may be obtained (quoting reference L800/C) from the Establishment Officer, University House, Bailrigg, Lancaster, LA1 4YW to whom applications (five copies naming three referees) should be sent not later than 15 March 1974.

CHELSEA COLLEGE University of London LABORATORY TECHNICIAN (Grade 2B)

required as soon as possible for the Department of Pharmacy. The main duties will be responsibility for the upkeep of teaching and research laboratories and associated small scale laboratory chemical manufacturing equipment and allied physical instruments. Salary Scale: £1800-£1900 per annum (including London Allowance). Application forms from the Manager of Technical Services (N3) Chelsea College, University of London, Manresa Road, London, SW3 6LX.

THE UNIVERSITY OF MANCHESTER LECTURER IN BIOCHEMISTRY

Applications invited for this post, to assist with the teaching of Biochemistry to Honours and subsidiary students in the Department of Biochemistry in the Faculty of Science. Salary range p.a.: £1929-£2450; initial salary point not above £2388. FS5U. Particulars and application forms (returnable by 9 March) from the Registrar, The University, Manchester, M13 9PL. Quote ref: 15/74/NS.

BRIITISH MUSEUM (NATURAL HISTORY) ASSISTANT SCIENTIFIC OFFICERS (Men and Women)

required to assist in the Departments of Zoology, Entomology, Botany, Mineralogy and Palaeontology including Anthropology where the work consists principally of identifying and naming specimens, maintaining catalogues and registers of the collections and compiling indices to the technical and scientific literature. Also in the Museum Library, where the duties involve acquisitions, subject and bibliographical enquiries and general reference work. Minimum qualifications, four passes in GCE or equivalent, including English Language and a science or mathematical subject.

Age normally under 26 on 31 December 1974. Starting salary (Scale under review) £675 (age 16)-£1397 (age 25) according to age, rising by annual increments to £1612, plus £175 Inner London Weighting. Application forms from Miss S Hayward, British Museum (Natural History), Cromwell Road, London SW7 5BD, telephone 01 589 6323. Closing date 15 February 1974.

RESEARCH DEMONSTRATOR required in Department of Agriculture and Horticulture, University of Reading, for a 3 year period to assist with practical classes and to carry out research on temperate fruit crops leading to a higher degree (fees paid by the University). Good honours degree in horticulture or botany essential. Salary scale £1047 x 5/15-£149 p.a. Applications to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading, Berks, RG6 2AH, quoting Ref. TS12.

ROYAL VETERINARY COLLEGE

(University of London)
Department of Medicine
Hewkhead Lane, North Mymms, Herts.

TECHNICIAN (Grade 3)

to work in the microbiology section of the department's clinical laboratories. Candidates should have appropriate technical experience and intermediate qualification. Established post. London University pay scale plus £90 p.a. London Allowance.

TECHNICIAN (Grade 2B)

to undertake varied duties involved with veterinary research. Previous technical experience desirable plus willingness to learn. London University pay scale plus £90 p.a. London Allowance. Grant funded post for 3 years.

Both posts carry good holidays, with superannuation and educational release where appropriate. Apply in writing to J. F. A. Boag, (NS), Personnel Officer, Royal Veterinary College, Boltons Park, Potters Bar, Herts.

Further details may be obtained from G. W. Swayne, Chief Technician, at Potters Bar SW496.

TONBRIDGE SCHOOL Physics

PHYSICIST

required for September 1974 to teach at all levels up to University Scholarship, including Nuffield 'A' Level Physics. Accommodation available for married or single man. Tonbridge salary scale above Burnham.

Applications, with names of two referees, by February 1974 to the Headmaster, Tonbridge School, Kent, from whom further details can be obtained (Tonbridge 4946).

LEEDS POLYTECHNIC

Department of Librarianship
**SENIOR LECTURER/
 LECTURER II/LECTURER I
 IN INFORMATION SCIENCE**

Applications are invited to join a team teaching the CNAAL B.Sc. Honours Information Science course and to undertake other work on Short and other special-interest courses.

Candidates should have sound industrial experience preferably as an information specialist or special librarian. Membership of the Institute of Information Scientists or Graduate Membership of the Library Association would be an advantage.

Salary Scales: Lecturer I: £1060-£2685 (bar); £2847. Lecturer II: £2515-£3245. Senior Lecturer-£3291, £3639 (bar); £3928.

Details and application forms from the Academic Officer (NS1), Leeds Polytechnic, Calverley Street, Leeds LS1 3HE, to whom applications should be submitted as soon as possible but not later than 15th February 1974.

**UNIVERSITY OF READING
 Department of Microbiology
 RESEARCH
 DEMONSTRATORS**

Applications are invited for several posts of Research Demonstrator in the Department of Microbiology, commencing 1st October 1974. Applicants should have qualifications in Microbiology, Bacteriology, Biochemistry or related subjects. A demonstrator will be expected to demonstrate in practical classes up to eight hours per week during term and to engage in research for a higher degree (MPhil or PhD). Salary scale £1,047 to £51-£1,149 p.a. Further particulars from Dr L. J. Catman, Department of Microbiology, University of Reading, London Road, Reading, RG1 5AQ. (Ref. TS1).

**THAMES POLYTECHNIC
 Division of Materials Science
 LABORATORY
 TECHNICIAN**

Laboratory Technician, preferably with some experience in the preparation of inorganic chemicals, required on a fixed-term contract. Although O.N.C. or equivalent would be preferable, ability and willingness to work rather than qualifications are important. Salary within the range £1740-£2010 per annum.

Application form and further information from the Secretary, Thames Polytechnic, Effingham Street, London, SE18 6PP to whom completed applications should be returned as soon as possible.

**UNIVERSITY OF WARWICK
 LECTURES IN
 MICROBIOLOGY**

Applications are invited for a Lectureship in the Department of Biological Sciences, with a special interest in microbiology. The appointment will be made within the first four points of the Lectureship scale £1823, £2053, £1853, £2083, £2308 p.a. The salary will be commencing from October 1974. Further particulars and application forms may be obtained from the Academic Registrar, University of Warwick, Coventry CV4 7AL, quoting Ref. No. 28/70/74, to whom completed forms should be returned by 25th February 1974.

Physical Tests Supervisor

Maidenhead

The De La Rue Research Centre provides central research and development support to a large international group of companies in the fields of polymers, reinforced polymers and ceramic foams. Within this structure the physical testing laboratory makes a vital contribution to product improvement and new product development.

The job. To co-ordinate the work of a group in carrying out tests such as accelerated weathering, mechanical, electrical and fire testing according to specific standards relevant to the plastics industry, and to provide a creative approach to new test method development in collaboration with national and international organisations.

The person. A degree or equivalent is desirable, but at least four years' experience related to testing, with two years in a supervisory capacity, is essential.

The Research Centre has an active sports and social club and employment benefits include four weeks' holiday, BUPA membership, free life cover and contributory pension scheme. Please write for an application form to: Mrs M. Malcolm-Lawes, Personnel Officer, The De La Rue Co. Ltd, 84/86 Regent Street, London W1A 1DL

De La Rue Research Centre



RESEARCH & DEVELOPMENT CHEMISTS

Hopkins & Williams, a member of the Saarl Group of Companies

As a result of expansion of our manufacturing activities, a number of vacancies have arisen for chemists to work in our Research and Development Department shortly to be transferred to our factory at Heverhill (Suffolk).

The work, which is interesting and varied, consists of organic and inorganic synthesis directed towards the development of manufacturing processes. Collaboration with production chemists will therefore be involved. One of the vacancies involves particular responsibility for trouble shooting.

Applications are invited from graduate chemists with approximately two years experience of synthetic chemistry.

A vacancy also exists for an assistant. Suitable qualifications would be O.N.C. or GCE 'A' level in chemistry and preferably some relevant experience. Day release will be granted to successful applicants to follow an approved course.

Please apply in writing to:

Senior Personnel Officer
 Hopkins & Williams, P.O. Box 1, Romford, Essex RM1 1HA

**UNIVERSITY COLLEGE,
 CARDIFF**

Department of Mechanical
 Engineering
RESEARCH ASSISTANTS

Applications are invited from persons with a good Honours degree in mechanical engineering, applied physics or civil engineering for the following appointments: 3 Research Assistants to work with Dr B. J. Brinkworth.

SOLAR ENERGY

One Assistant to work on an industry-sponsored investigation of the optimisation of design parameters for solar heaters and related devices.

SOIL DYNAMICS

One Assistant to work on an investigation, sponsored by the Ministry of Defence, of dynamic properties of soils in relation to the resistance to motion of a tyre wheel on soft ground.

These appointments will be for a period of two or three years, with salaries in the range £1600-£2553 p.a. Preference will be given to applicants with appropriate postgraduate experience. Arrangements may be made for the persons appointed to undertake their work in candidature for a higher degree.

Applications, giving a brief curriculum vitae and names and addresses of two referees, should be sent to the Registrar, University College, 230-232, Bowdoin, Cardiff CF1 1XL. Closing date is 25 February, 1974. Please quote ref. 0988.

**INSTITUTE OF
 OPHTHALMOLOGY**

(University of London)

Judd Street,

London, WC1H 9QS

Vacancies exist for a young immunologist, preferably post-doctoral, with experience in cell-mediated immunity, to join a project of research on the role of cell-mediated immune mechanisms in human chlamydial disease. This work is associated with clinical and laboratory projects on ocular and genital chlamydiae, on trachoma in London and hyperemic trachoma in Iran. The appointment will be for three years, with salary £2053 p.a. Commencing salary £2058 plus £162 London Allowance. Applications with full details of qualifications and experience, together with names of two referees to The Secretary at the above address by 8 February, 1974.

**SOUTH METROPOLITAN
 CANCER REGISTRY**

Has a vacancy for a graduate Scientific Assistant. Subjects of Study which will be considered relevant include: Biology, Mathematics, Statistics and Computing. The Science, the appointment will be the first instance on the Whitley Council General Administrative Grade (Phase 2: £1812-£2513 including London Allowance) with transfer to the Senior Administrative Grade £2313-£2847, after a period of satisfactory service.

Applications and requests for further details to be made by writing to the Director, South Metropolitan Cancer Registry, Clifton Avenue, Clifton, Bristol, Surrey. Telephone 01 642 7652.

**CHELSEA COLLEGE
 University of London**

A TECHNICIAN (Grade 4)

is required to be responsible for the organic chemistry teaching laboratory of the Pharmaceutical Chemistry Section of the Department of Chemistry. A B.Sc. H. qualification and relevant experience are essential. Salary £2023-£2538 per annum (including London Allowance). Application forms from the Registrar of Technical Services, (NS), Department of Pharmacy, Chelsea College, Mansee Road, London, SW3 6LX.

UNIVERSITY OF SURREY

Department of Chemistry
Applications are invited for the post, available immediately, of
RESEARCH OFFICER
to work in the laboratories of the Department of Chemistry for a period of two years.

The work is concerned with a study of the absorption of ionic species on to hydroxyapatite with the ultimate aim of understanding substantive reactions of ions with teeth.

Duties will consist mainly of laboratory work in solution and solid phase chemistry and include spectrometric and X-ray crystallographic analysis.

Qualifications: First degree, HND or HNC and appropriate experience.

Salary: Within the research officer's range, £1095-£2228, the position on this scale at appointment depending on qualifications and experience.

Applications giving full details of age, qualifications and experience together with the names of two referees should be addressed to Dr D. P. Benton, Department of Chemistry, University of Surrey, Guildford, GU2 5XH.

UNIVERSITY OF MELBOURNE

LECTURER IN INVERTEBRATE BIOLOGY
in the Department of Zoology

Qualifications: Ph.D. with some experience in teaching and in organising courses.

Duties: To contribute to the first year Biology course, to conduct or assist in Unit Courses in second and third years. The Lecturer will be encouraged to develop a personal research programme and to supervise graduate students.

The Department has excellent modern facilities for electron microscopy (both transmission and scanning), electrophysiology, histology and cytochemistry, tissue culture, bioacoustics and marine Zoology. The Head of the Department is Professor G. Burnstock.

Salary range—\$A\$8955-\$A\$11 982. The initial salary will be determined according to qualifications and experience.

Further information, including details of superannuation, travel and removal expenses, housing assistance and conditions of appointment, is available from the Association of Commonwealth Universities (Apts), 36 Gordon Square, London, WC1H 0PF.

Applications close on 28 February, 1974.

MEDICAL RESEARCH COUNCIL

Radiobiology Unit, Harwell, Berkshire.

Technical Assistant (Biologist) wanted. Excellent opportunity for Young Graduate to join a research group investigating genetic effects of radiation and other agents in small animals. Varied work involving animal genetics, cytogenetics, tissue culture, etc. Salary according to age and qualifications. Fringe benefits include modern hostel accommodation for single men and women at a reasonable cost, excellent social facilities and proximity to Oxford. Applications, in writing to: The Administrator, Medical Research Council, Radiobiology Unit, HARWELL, Berkshire. Reference MFL/34.

CENTRAL PUBLIC HEALTH LABORATORY

We have a part-time vacancy in our Salmonella and Shigella Reference Laboratory for an Honorary Science Graduate, preferably in microbiology, to work in the E. Shigella section. Hours by arrangement.

Applications to the Personnel Officer, Central Public Health Laboratory, Colindale Avenue, London, NW9 5HT.

Find your place in British Gas

ANALYTICAL CHEMISTS

A Technical Officer and a Scientific Assistant are required by British Gas London Research Station to work on chemical analysis of a wide variety of materials using modern analytical techniques.

For the Technical Officer post, H.N.C. in Chemistry and Laboratory experience are essential, and candidates must be able to work with the minimum of supervision.

Scientific Assistants should have a minimum of 5 'O' levels including two scientific subjects and, preferably, 2 'A' levels, one of which should be in Chemistry.

Starting salary will be according to age and qualifications on a scale rising to £2367 for Scientific Assistants and £2661 or, exceptionally, £2913 for Technical Officers, good conditions of service including subsidised restaurant and sick pay schemes together with opportunities for educational advancement.

For further details and application form, contact

Research Secretary, British Gas Corporation,
London Research Station, Michael Road,
Fulham S.W.6, quoting reference 4000.6.

BRITISH GAS

RESEARCH AND DEVELOPMENT CHEMIST

A vacancy exists in a small team examining the performance of primary and secondary cell electrodes.

The position will be best filled by a GOOD HONOURS CHEMISTRY GRADUATE, aged up to 25 years, with an interest in physical/inorganic chemistry and an aptitude for practical work.

Good opportunities exist for advancement within the laboratories or the Company at large.



Apply:

Administration Manager,
The Ever Ready Co. (G.B.) Ltd.,
Central Laboratories,
St. Ann's Road, London N15 3JT
Tel. No. 01-800 1101

Applications are invited for a

MEDICAL PHYSICS TECHNICIAN
Grade III

to maintain and develop electronic equipment at the

Burden Neurological Hospital, Bristol

He will be expected to assist with advanced electro-physiological studies of psychiatric and neurological patients.

The successful candidate will belong to the Regional Physics Centre but will be permanently employed at the above hospital.

Application forms can be obtained from—

Dr. H. F. Freundlich, Department of Medical Physics, Board of Governors of the United Bristol Hospitals, Bristol General Hospital, Bristol BS1 6SY.

UNIVERSITY OF SURREY

Department of Metallurgy and Materials Technology

Applications are invited for the posts of Research Fellow and Research Officer tenable in the Department of Metallurgy and Materials Technology at the University of Surrey.

Applicants for the first of these posts should have a PhD or equivalent experience in Materials Technology, preferably in composite materials, ceramics or plastics. The Fellow appointed will undertake research on materials of interest in construction and building and in detail will be concerned with the property/structure relationship of structural materials. He will be expected to liaise closely with Redland Ltd.

Applicants for the post of Research Officer should have a degree or equivalent training in some aspect of materials science or technology and an interest in or experience of fibre composite materials. Experience in the effect of fabrication on the properties of fibre reinforced composites would be advantageous.

Remuneration would depend on age and experience and for the Research Fellow would be made in relation to the Civil Service scales, in the range £1529 to £2716, and for the Research Officer an appointment would be made within the salary range £1900 to £2400.

Applications should include a curriculum vitae and be sent to Professor J. E. Bailey, Department of Metallurgy and Materials Technology, University of Surrey, Guildford, Surrey GU2 5XH.

LIVERPOOL POLYTECHNIC

School of Pharmacy
RESEARCH ASSISTANT IN PHARMACOLOGY

Applications are invited from graduates (or those expecting to graduate) in Pharmacy, Pharmacology, Biochemistry or related disciplines for the post of Research Assistant in the Pharmacology Section of the School of Pharmacy. Industrial experience in biochemically orientated pharmacological techniques would be an advantage, but is not essential. The successful applicant will be registered for a PhD of the Council for National Academic Awards, which will be completed in 3 years. Research will be in the field of Psychopharmacology, with special reference to the relationships between changes in brain monoamine metabolism and behaviour induced by hormones and drugs. Salary will depend on previous experience but will be within the range £1353-£1644 p.a. Informal enquiries may be made to Dr Sally R. Tonge, 051 207 581 ext. 7. Completed application forms should be returned to the Staff Office, Dept. No. 6, Liverpool Polytechnic, Richmond House, 1 Rumford Place, Liverpool, L3 5EH not later than three weeks after the appearance of this advertisement.

SYNCRYST

Crystal Growers and Consultants
Require a
TECHNICIAN

For interesting and varied work in assisting a small team on several crystal growing projects. We are looking for a young man or woman aged 18-25 with a scientific background and interests in physics and chemistry who can act on their own initiative. Their release may be offered to help further his or her career. Salary is negotiable and prospects and benefits are in our small expanding company.

For further details write or telephone—
The Secretary, Syncrest Ltd.,
Molesley Avenue, East Molesey,
Surrey, KT8 8RY. 01-878 3317/8/70.

THE ROYAL FREE HOSPITAL

Gray's Inn Road
London WC1

TECHNICIANS

Post 1. To work mainly with Gamma Cameras and Scanners in a wide variety of clinical investigations and to prepare radiopharmaceuticals for this application. From July 1974 the department will have two gamma cameras and three scanners in the New Royal Free Hospital. Opportunities will be available for participating in the general work of the department including Whole Body Counting, Radiation Protection and Data Processing.

Post 2. To be involved in a wide range of interesting laboratory work including, for example, Liquid Scintillation Counting, Radio-immunoassay and Data Processing as well as collaborating in research projects. A background including some experience of chemical procedures would be particularly suitable for this post. Experience in data processing not essential since some training could be given.

The department is scheduled to move into the new 873 bed Teaching Hospital near Hampstead Heath in 1974.

Appointment to Post 1 may be on Grade III (£1845-£2337), Grade IV (£1856-£2079) or Grade V (£1434-£1893).

For Post 2 it is hoped to appoint on Grade III.

Further particulars from the Chief Physicist (Tel. No. 01-537 6411 Ext. 12).

**UNIVERSITY OF HULL
LECTURER IN GEOLOGY**

Applications are invited for a Lecturer in Geology to have responsibilities in the teaching of stratigraphy and palaeontology generally.

Preference may be given to a candidate with research interests in Applied Micropalaeontology. Equipment in the Department includes both steroscan and transmission electron microscopes.

The appointment will date from October 1974 or perhaps earlier. The starting salary will be in the lower part of the Lecturer Scale (£1929-£4548 per annum, with FSSU benefits).

Applications (6 copies) giving details of age, qualifications and experience together with the names of three referees should be sent by 9 March, 1974, to the Registrar, from whom further particulars may be obtained.

UNIVERSITY OF LONDON**Institute of Psychiatry
DEPARTMENT OF
NEUROPATHOLOGY**

Applications are invited from graduates to join a team investigating brain metabolism (in patients and experimental animals). The work involves supervision of immunoassay, analytical and chromatographic work (auto-analyzers and amino acid analysers with on-line data processing units). The presence of modern instrumentation at an advantage but not essential. The University of London computer is used. Opportunity to work for higher degree. Starting salary in range £1746-£2460 including London allowance. Please write to the Secretary, Institute of Psychiatry, De Crespigny Park, Denmark Hill, London SE5 8AF quoting reference PMD/NS for application forms or telephone 01-705-3111 ext. 228.

Technicians

for

Sainsbury's Laboratories

We have a reputation for selling high quality food products, and our laboratories, situated close to Blackfriars, Waterloo and London Bridge stations, work to ensure that our standards are maintained.

We have vacancies for technical staff to work in our Research, Microbiology, Chemical Control, Non-Foods, and Packaging laboratories and applications are invited from school leavers with 'O' or 'A' levels in science subjects as well as those with experience or educated to HNC level.

All positions offer wide interest and career progression for the right people as well as day release for agreed courses. We work a 37 hour week, Monday to Friday. Salaries are good and there is an excellent subsidised staff restaurant, contributory pension scheme and a lively sports and social club.

Please write or telephone for an application form, quoting Ref. LB/6 to: Miss P. Loveday, J. Sainsbury Ltd, Stamford House, Stamford Street, London, S.E.1. 01-928-3355 ext. 2775.

SAINSBURY'S

Middlesex Polytechnic

Laboratory Technician for Physical Geography/Geology

A technician is required to provide technical support in physical geography/geology at our Hendon site. Applicants for this post should have had an appropriate technical background and some experience of laboratory work in soil science or general science.

Salary Scale: T.3 £1521-£1749.

Application forms and further details from the Appointments Officer, Ref. NSC/1/29, Middlesex Polytechnic, Queensway, Enfield, Middlesex EN3 4SW. Completed forms should be returned by 15th February 1974.

LEEDS POLYTECHNIC

LIFE SCIENCES DEPARTMENT

Senior Laboratory Technician T4 (ref. 32/12) (£1,644-£1,726) (with possible additional technical allowance)

Applications are invited for the above post. The person appointed will be responsible to the Chief Technician for the organisation and day-to-day running of the biochemistry laboratories, preparation of material for classwork, the maintenance of equipment within this section, and supervision of junior staff.

Application forms (quoting ref. no.) from the Administration Officer, Leeds Polytechnic, Calverley Street, Leeds LS1 3HE, and should be returned as soon as possible.

THE AUSTRALIAN NATIONAL UNIVERSITY

Research School of
Biological Sciences
Department of
Development Biology
TECHNICAL OFFICER/
SENIOR TECHNICAL
OFFICER

Applications are invited for a senior position in a new research group headed by Professor B.E.S. Gunning.

The group will be studying the ultrastructure of plant cells using light microscopy, electron microscopy and scanning electron microscopy and x-ray microanalysis. Previous experience of electron microscopy and techniques of specimen preparation will be of advantage.

Appointment and salary will be within one of the following ranges, according to qualifications and experience: Technical Officer \$A6003/\$A7613; Senior Technical Officer \$A7864/\$9103.

Professor Gunning can be contacted at the Botany Department, Queens University, Belfast, up to 28 February 1974, telephone 43153, Extension 631.

Assistance with passages and accommodation will be provided.

The successful applicant will be required to undergo a medical examination. Written applications, quoting reference number 74048, should be forwarded to the Registrar, The Australian National University, P.O. Box 1, Canberra, A.C.T., 2614, Australia, with whom applications close on 16 February 1974.

**GLASSHOUSE CROPS
RESEARCH INSTITUTE
requires**

Technician for Instrumentation & Control Section for construction, installation and maintenance of wide range of instruments and laboratory equipment. Minimum qualifications ONC or equivalent in appropriate subject. Candidates must have served an apprenticeship or have had equivalent training appropriate to duties of the post and normally three years additional experience. Salary in grade of Professional & Technology Officer IV £1747 at age 24, £1862 at age 26; maximum starting pay on appointment at age 28 or over £1976; maximum of scale £2226; plus 5 1/2% superannuation allowance.

Further particulars from Secretary of the Institute, Worthing Road, Rustington, Littlehampton, Sussex, BN16 9PU to whom applications giving full biographical details should be sent by 15th February.

**PLYMOUTH
POLYTECHNIC
School of Environmental
Sciences
Senior Chemistry
Technician (T3)**

required to take charge of suite of laboratories covering pollution chemistry, biological chemistry, geo-chemistry and physical chemistry.

Qualifications: H.N.C. (1 year success) or equivalent with considerable relevant experience. Salary £1416-£1644 (plus additions for certain qualifications). Application forms and further details may be obtained from the Establishment Officer, Plymouth Polytechnic, Plymouth, PL4 8AA, and should be returned within 10 days of the date of this advert.

THE UNIVERSITY OF LEEDS

DEPARTMENT OF PLANT SCIENCES

Amended Advertisement

Applications are invited for the post of **EXPERIMENTAL OFFICER**

at the Leeds University Field Station, Nr. Tadcaster. Candidates should have a degree in Agriculture or in agricultural science and with an interest in crops. The post is full-time, with a salary of £12,000 per annum, renewable for a further two years with a possibility of further extension. Salary will be within the scale £12,000-£12,187.

Forms of application and further particulars from the Registrar, The University, Leeds LS2 9JT (Telex quote 41A-9). Closing date 15 February 1974.

KING'S COLLEGE HOSPITAL MEDICAL SCHOOL

(University of London)
Denmark Hill, London
SE5 8RX

SENIOR RESEARCH BIOCHEMIST

required to join multidisciplinary group in a MRC supported programme into the development of the artificial liver with particular reference to brain metabolism. Ph.D. preferred. Salary within the range £2588-£3948 plus £162 London allowance. Further particulars from Dr. R. Williams, Liver Unit, Applications to The Secretary of the Medical School not later than 8th-February, 1974.

LIVERPOOL POLYTECHNIC Department of Maritime Studies

SENIOR LECTURER/LECTURER II

to teach in the field of meteorology and marine environmental studies to first degree level. Applicants should have preferably a degree in physical sciences but suitably qualified mariners would be considered. SALARY: SENIOR LECTURER (£3,291-£3,928. LECTURER II (£2,515-£3,243. Details available from Staff Office, Dept. 'NS', Liverpool Polytechnic, Richmond House, 1 Rumford Place, Liverpool, L3 9RH.

THE CITY UNIVERSITY

Department of Civil Engineering
GEOLOGY TECHNICIAN

A Grade 4 Technician is required to supervise and maintain the Geology Laboratory. Experience in this field is essential. An ability to undertake simple cartographic draughting would be an advantage.

Salary according to experience on the scale £2,105 to £2,715 £175 London Allowance. This post is supernumerary.

Apply in writing stating age, qualifications, experience and a present salary to The Personnel Officer, The City University, St John Street, London EC1V 4PB, quoting reference CE/4.

YORKSHIRE FIELD STUDIES LTD.

TWO FIELD TUTORS (MALE)

Yorkshire Field Study Centres—North Yorkshire Moors National Park. A Biologist and a Geographer both with good degrees and preferably teaching experience. Wide natural history knowledge would be added advantage. Salary Scale £837-£1131 with full residential emoluments. Applications to Director of Studies, Field Studies Ltd., Larpool Hall, Larpool Drive, Whitby, Yorks. YO22 4ND.

TATE & LYLE LIMITED

GROUP RESEARCH AND DEVELOPMENT

SENIOR RESEARCH ASSISTANT

required to join a team investigating microbial processes using continuous culture techniques. Previous experience with laboratory scale fermenters and mechanical aptitude is necessary. The successful candidate will also be responsible for maintenance of the extensive yeast and microfloral collection. Qualifications required: H.N.C. or B.Sc. in Biology.

Salary will be competitive reflecting ability and experience. Conditions of employment include a five day week, free lunches, a non-contributory pension scheme, a minimum of three weeks' holiday and annual bonus.

Applications giving full personal and professional details should be addressed to the Administration Manager, Tate & Lyle Limited, Philip Lyle Memorial Research Laboratory, The University, Whiteknights, P.O. Box 68, Reading, RG6 2BX, Berkshire.

UNITED SHEFFIELD HOSPITALS NON-MEDICAL SCIENTIFIC OFFICER

required until October, 1975 to take part in a research project investigating into the Excretion of Sulphated Corticosteroids in Breast Cancer.

Applicants should possess a first or second Class Honours degree. Whitley Council Terms and Conditions of Service apply. Salary £1680-£2212 p.a.

Applications stating age, qualifications and experience naming two referees to the Acting Chief Administrative Officer, United Sheffield Hospitals, 10 Beech Hill Road, Sheffield, S10 2BZ. Further details supplied on request. Closing date for applications 16th February, 1974.

UNIVERSITY OF CAMBRIDGE ANIMAL PRODUCTIVITY/ NUTRITION

Applications invited for a vacant University Demonstration in Animal Productivity/Nutrition in the Department of Applied Biology. Qualifications — good Honours degree in animal sciences with research experience in some aspect of animal productivity involving nutrition and biometry and some teaching experience. Salary scale £2058-£2718. Starting point determined according to seniority. Pensionable under FSSU. Limited contribution to removal expenses. Further details from and applications including full personal and academic details, names and addresses of not more than three referees to the Secretary, Appointments Committee of the Faculty of Biology "A" Department of Applied Biology, Downing Street, Cambridge, CB2 3DX, not later than 28 February, 1974.

KING'S COLLEGE HOSPITAL MEDICAL SCHOOL

Denmark Hill, London,
SE5 8RX

Junior Research Technician

required in the above department to participate in a project relating to nutrition and the immune system. The work will be mainly concerned with biochemical analysis and the successful applicant will be a member of a team studying related aspects of the problem. Salary according to age and experience. Applications with the names of two referees to the Secretary of the Medical School by 25 January, 1974.

NATIONAL INSTITUTE FOR BIOLOGICAL STANDARDS AND CONTROL

Applications are invited for the post of LIBRARIAN. The Institute is responsible for the standardisation and control of biological substances used in medical research and clinical practice. Applicants should hold a qualification in Librarianship. Appropriate subject knowledge would be an advantage. Initial salary according to age, experience and qualifications, within the range £1,439-£2,837, plus superannuation supplement of £86-£145. Candidates should send a resume of their career and the names and addresses of two referees to the Director, National Institute for Biological Standards and Control, Holly Hill, Hampstead, London, NW3 6BH.

THE UNIVERSITY OF SHEFFIELD

CHAIR OF APPLIED MATHEMATICS

Applications are invited for the CHAIR of APPLIED MATHEMATICS vacant on the appointment of Professor P. C. Kendall to the Headship of the Department of Mathematics at the University of Keele. Salary in the range appropriate for professional appointments with F.S.S.U. provision. Further particulars may be obtained from the Registrar and Secretary, The University, Sheffield S10 2TN, to whom applications (one copy only) should be sent by 25 February 1974. Quote Ref. R22/H.

CHEMIST OR METALLURGIST having a good honours degree or equivalent and preferably with experience of electrodeposition is required by a large industrial R & D organisation to investigate novel plating baths including the qualification of deposits. Age up to approximately 30 years. Research AC20. Reply to The Secretary, British Non-Ferrous Metals Research Association, Grove Laboratories, Denchworth Road, Wantage OX12 9BJ.

FELLOWSHIPS, GRANTS AND SCHOLARSHIPS

UNIVERSITY OF SOUTHAMPTON SCHOOL OF EDUCATION and **THE BRITISH PETROLEUM COMPANY LIMITED** BP SCHOOL TEACHER FELLOWSHIP "Outdoor Science and Mathematics"

The Schoolteacher Fellow will be expected to investigate the outdoor environment as a source of experimental work which will enable children to learn about science computing to biology and other sciences and to produce materials for teaching materials. Quite useful to teachers wishing to initiate experimental work out of doors.

The investigation will be at secondary school level and will be for one year commencing on 1 September, 1974.

Arrangements will be made for present salary and superannuation to be maintained plus a small emolument. The gross cost will not exceed £250.

Further details may be obtained from the Deputy Secretary's section (751) at the University of Southampton, to whom applications should be sent not later than 9 March 1974. Telex quote reference NS/781/A.

KINGSTON POLYTECHNIC RESEARCH FELLOW

To work on Environmental Pollution Studies in Estuaries

Applications are invited from suitable candidates to work with a group of staff on a major study of pollution in selected estuaries. The work will be co-ordinated by Dr. W. O. George, Reader in Spectroscopy, in the School of Chemical and Physical Sciences. The candidate will probably have a higher degree in Zoology or Marine Biology with extensive knowledge of quantitative measurements and relating these to broad environmental questions. The successful candidate will be a Physical or Earth Sciences will be considered.

The appointment will be for 1 year renewable for a second and a third year at salary on the Institute scale. The post will be determined by qualifications, age and experience.

Application forms and further details from The Appointments Officer, Kingston Polytechnic, Penryn Road, Kingston upon Thames, Surrey KT1 2EE.

UNIVERSITY OF MANCHESTER

RESEARCH FELLOW Departments of Child Health and Community Medicine

Applications invited from science graduates with research experience including the use of statistics in epidemiological study of the 2000 or so cases of childhood cancer in the Manchester Children's Tumour Registry. Three-year appointment with the status of Research Fellow of Health, U.S.A. Suitable training post for a career in cancer epidemiology. (For details see Ref. NS/1929 p.a. Further details and application forms (returnable by 25 February) to be sent to The University, Manchester, M13 9PL. Quote Ref. No. 6/74/NS.

THE UNIVERSITY OF SHEFFIELD

Department of Chemical Engineering and Fuel Technology

POST-DOCTORAL FELLOWSHIP AND RESEARCH ASSISTANT

Applications are invited for a Post-Doctoral Fellowship in the field of Air Pollution from Aircraft. The research work is supported by a grant from the United States National Aeronautics and Space Administration and will be carried out as part of a joint research project with the Department of Mechanical Engineering at the Massachusetts Institute of Technology in Boston. Experiments will be carried out at Sheffield University on the combustion efficiency and pollution characteristics of swirl burner modules used in the NASA gas turbine combustion chambers. Velocities will be measured in the flames by a laser anemometer and temperatures and gas concentrations will also be measured in the flames. Provision is made in the budget to allow visits to MIT and NASA Research Centres in the United States. Initial salaries are according to experience up to £5048 for the Post-Doctoral Fellow and up to £2655 for the Research Assistant. The Research Assistant may be able to register for a Ph.D. in which case a stipend salary will be imposed. Applications giving the names of two referees should be sent to Dr. V. N. A. Chigier, Reader in Chemical Engineering and Fuel Technology, The University of Sheffield, 51 SJD, Quote Ref. R.12/H.

THE NUFFIELD FOUNDATION

TRAVELLING FELLOWSHIPS IN MARINE BIOLOGY (TROPICAL & SUB-TROPICAL)

The Nuffield Foundation offers two fellowships per annum to enable biologists in UK universities to travel to travel overseas (normally for a period of between six and twelve months) to gain scientific experience in the marine environments in tropical and sub-tropical regions. Consideration can also be given to applications from physical scientists and from candidates who may be working in institutions other than universities. The primary aim of the scheme is to enliven and to broaden the scope of biology teaching at the tertiary level. The fellowships are open to men and women holders of UK or other Commonwealth university degrees. The value of the awards will be determined on an ad hoc basis but will cover fares, subsistence allowances, and contributions to equipment and running expenses.

Applications, for awards to be taken up in 1975, should be submitted by 31st March 1974. Further particulars and forms of application are available from the Nuffield Foundation, Nuffield Lodge, Regent's Park, London NW1 4NS.

UNIVERSITY OF SUSSEX

School of Biological Sciences

RESEARCH FELLOW

Post-doctoral Research Fellow required as soon as possible until 30 September, 1974, with the possibility of one or two years' extension to assist with studies on the effects of viruses on endocrine tissue. Medical or biological background is an advantage.

Salary range £1929-£2718 according to age and qualifications.

Applications and visits names of two referees should be made to Secretary of Science, Science Office (E), University of Sussex from whom further details can be obtained.



AUSTRALIA

Queen Elizabeth II FELLOWSHIPS

in the Physical and Biological Sciences

To commemorate the Royal Visit to Australia in 1963 the Australian Government established the Queen Elizabeth II Fellowships Scheme. Under this scheme up to ten fellowships may be awarded each year for full-time research by young scientists of exceptional promise and proved capacity for original work. These are post-doctoral awards tenable in an Australian university or approved research institution, normally for two years. Tenure of a Fellowship will commence on a date which normally should be within nine months of the date of the award.

QUALIFICATIONS Queen Elizabeth II Fellows must be either Australian or United Kingdom citizens. They should have a Ph.D., or equivalent qualifications, in one of the physical or biological sciences (which are deemed to include mathematics and the scientific aspects of statistics, engineering, metallurgy, agriculture and medicine). Awards will, in general, be restricted to applicants who are not more than 30 years of age on the date when applications close.

STIPEND \$9,500 (Australian) per annum – increased to \$10,250 per annum at age 28 years.

ALLOWANCES are payable in respect of a Fellow's wife (\$500 p.a.), each dependent child (\$200), superannuation payments (up to 10 per cent of stipend), appropriate insurance coverage and necessary travel expenses. Host institutions are paid an allowance towards the cost of setting up a Fellow and his research work.

APPLICATIONS Persons interested in applying for the above fellowships should obtain application forms and a statement of the conditions of award from the Secretary, Queen Elizabeth Fellowships Committee, Department of Science, P.O. Box 449, Woden, A.C.T. 2606, Australia; The Education Liaison Officer, Canberra House, Strand, London, W.C.2, England; or The Consul General, Australian Consulate General, 636 Fifth Avenue, New York 20, N.Y., 10020, U.S.A. Applications for the next round of awards, which will be announced in JUNE, 1974, close at the Canberra address on 1 MARCH 1974.

UNIVERSITY OF STRATHCLYDE

DEPARTMENT OF SHIPBUILDING AND NAVAL ARCHITECTURE

RESEARCH FELLOWSHIP

The Department has been awarded a research contract by the Marine Division of the Department of Trade and Industry to study the effects of motions on ship/marine vehicle stability.

Applications are invited from naval architects and engineers with good mathematical background or applied mathematicians.

The successful applicant will be expected to work with an existing team and to develop analytical and numerical techniques.

Salary scale: up to £2550 with F.S.S.U. benefits.

Application forms and further particulars (quoting R/74) may be obtained from the Registrar, Royal College Building, University of Strathclyde, 204 George Street, Glasgow, G1 1XW with whom application forms should be lodged by 4th February, 1974.

UNIVERSITY OF ESSEX

Department of Chemistry

Applications are invited for RESEARCH FELLOWSHIPS

In each of the following fields:

1. Crossed molecular beam studies of elementary reactions (experience of scattering techniques would be of considerable advantage).
2. Chemi-ionisation studies by electron spin resonance (experience in spectroscopy would be of value).
3. Shock tube studies of combustion-generated pollution.
4. Shock tube studies of initiation in fuel-air mixtures.

Candidates are expected to hold an appropriate qualification such as an Honours Degree in Chemistry or Physics and have three or more years research experience, although candidates with less experience may be considered. Further details are available from Professor J. N. Bradley, Department of Chemistry, University of Essex, Wivenhoe Park, Colchester, CO4 3SQ, Telephone 0206-44144 Ext. 2030.

MEAT & LIVESTOCK COMMISSION

Postgraduate Training Scholarships

Applications are invited from graduates in Agriculture, Economics, Food Technology, Veterinary Medicine and related sciences associated with the British meat and livestock industry.

Tenure of two/three years from 1st October 1974 at United Kingdom universities or research institutions.

Value: Graduates in economics and veterinary medicine may be appointed at £1200, other graduates at £750 x 50 to £850. In addition, research expenses up to £500 per annum and a contribution to university fees of £100 per annum will be payable.

Further information and application forms, returnable by 1st March, 1974 obtainable from: Scientific Secretary, Meat and Livestock Commission, P.O. Box 44, Queensway House, Bletchley, Milton Keynes, MK2 2EF.

UNIVERSITY OF ADELAIDE POSTDOCTORAL RESEARCH FELLOWSHIPS

The University will award a number of Postdoctoral Research Fellowships in 1974 and 1975. These are held in any department of the University; however, Fellowships are already held in the following departments: Agriculture, Biochemistry and Soil Science, Chemical Engineering, Computing Science, Education, Electronics Technology, Mathematical Physics, Organic Chemistry, Physical and Inorganic Chemistry, Physics, Plant Pathology, Pure Mathematics and Zoology.

THE NORMAL AGE LIMIT will be 30 years, and preference will be given to an applicant who has qualified for the degree of Ph.D. or its equivalent within the last three years either elsewhere in Australia or in an overseas country.

TENURE may be for two years, with the possibility of extension for a third year.

SALARY SCALE A\$6867-353(4)-8379.

Up to A\$500 will be provided towards the cost of travel in coming to Adelaide. Up to the same amount may be provided if the Fellow should wish to return to his home state on the expiration of his fellowship and has no appointment which provides for travel and removal expenses.

APPLICATIONS in triplicate must be made on the prescribed form. Forms and a leaflet outlining the conditions of appointment may be obtained from the Registrar, University of Adelaide, South Australia 5001. Applications are considered twice yearly and must be lodged with the Registrar by 28 February or 1 July 1974.

POLYTECHNIC OF THE SOUTH BANK RESEARCH FELLOW

Applicants should have a good honours degree in one of the physical sciences, together with special knowledge of Electron Microscopy, and/or Any Aspect of Surface Science or Technology (e.g. Corrosion, Surface Treatment, Finishing or Polishing). Salary scale: £1868-£2239 per annum.

Further particulars from Mr. G. Foster, Head of Division of Metal Science, Polytechnic of the South Bank, Leamington Road, London, SE1 0AA. Tel. 01-828 8895.

UNIVERSITY OF KENT AT CANTERBURY Faculty of Natural Sciences RESEARCH FELLOWSHIP IN THE BIOLOGICAL LABORATORY

Applications are invited for a post-doctoral Research Fellowship concerned with physiological and genetic aspects of transmissible antibiotic resistance in bacteria. Bacteriological experience essential, with, preferably, some immunology or microbial biochemistry. Salary initially £1929 in the range £1929-£2223. Application forms and further particulars may be obtained from the Assistant Registrar, Faculty of Natural Sciences, Chemical Laboratory, University of Canterbury, Kent, to whom completed application forms should be submitted by 20 February, 1974. Please quote ref. A25/74.

STUDENTSHIPS

EAST MALLING RESEARCH STATION

Agricultural Research Council Studentship

V. H. BLACKMAN STUDENTSHIP

Studentships tenable at East Malling Research Station for three years from 1st October 1974, or research on the genetics, pathology or physiology of fruit trees.

First or upper-second Honours degree essential. Further details and application form from Assistant to the Secretary, East Malling Research Station, Maidstone, Kent, ME19 6BJ.

UNIVERSITY OF ABERDEEN

Department of Chemistry RESEARCH STUDENTSHIP IN POLYMER CHEMISTRY

Applications are invited for a research studentship to study the Chemical Modification of High Polymers. The project is financed by the Ministry of Defence and the grant has the same value as a S.C.S. Studentship.

Applications should be addressed to Dr. G. C. Cameron, Chemistry Department, University of Aberdeen, Meston Walk, Aberdeen, AB9 2UE, from whom further particulars may be obtained.

AGRICULTURAL RESEARCH COUNCIL

Letchmore Laboratory RESEARCH STUDENTSHIP

Applications are invited for an Agricultural Research Council post-graduate STUDENTSHIP tenable at Letchmore Laboratory for a period of three years commencing October 1974. The selected candidate will be able to undertake research, leading to a higher degree, within the programme of the Laboratory which is directed to studying the growth and function of plant root systems, and especially the way in which they are affected by soil environment.

Applicants should be British subjects normally resident in the United Kingdom and should have a first or upper second class honours degree in a relevant scientific subject. Full details of the value of the award, and further information on the work of the Laboratory can be obtained from the Secretary, Agricultural Research Council, Letchmore Laboratory, Wantage, OX12 9JT Berks. Closing date for receipt of application is 31 March, 1974.

POSTGRADUATE STUDENTSHIP

Applications are invited from graduates with first or upper second class honours degree. A general knowledge of biochemistry is required, preferably with a special interest in mitochondrial or muscle biochemistry.

The successful candidate will be expected to study the general biochemical properties of red and white, and fast and slow muscles. The project would involve assay of the composition of mitochondrial contents of the muscle, together with a study of their properties of P-ase, mitochondrial and Ca-pump activities.

The work is expected to form the basis of an MSc or PhD thesis. Further particulars of award, allowance, together with a form of application from the Secretary, Meat Research Institute, Langford, Bristol, BS18 7DY.

UNIVERSITY OF ABERDEEN DEPARTMENTAL STUDENTSHIP IN MEDICAL PHYSICS

Graduate Physicist required for three years to investigate the phenomenon of emission of light during dissolution of irradiated solids (polymers, etc.) and its possible application in dosimetry of ionizing radiations. Knowledge of chemistry or physical chemistry is an advantage. The candidate appointed will be expected to register as Ph.D. Post is financed by the National Radiological Protection Board. Value of studentship £595 per annum with dependants' allowances where appropriate.

Further particulars from The Secretary, The University, Aberdeen, with whom applications (2 copies) should be lodged by 16 February, 1974.

The University of Leeds DEPARTMENT OF PHYSICS POSTGRADUATE RESEARCH

A number of A.R.C. research studentships and similar grants will be available in the following fields:

High Pressure Physics
Low Temperature Solid Physics
Polymer Physics
Further information may be obtained from: Professor M. M. Perlman, Department of Physics, University of Leeds, Leeds LS2 9JT.

APPOINTMENTS WANTED

MALE GRADUATE, 24, B.Sc. (Hons), Zoology; aged 24, seeking long/short term work anywhere in Britain. Please write Box D743.

BURSARIES

THE UNIVERSITY OF SHEFFIELD

M.Sc. TECH BY RESEARCH

Scientists and Engineers with honours degrees are invited to apply for a bursary (£685+fees), to study the emission of infrared radiation from exhaust gas plumes. Please write to Dr. P. J. Foster, Department of Chemical Engineering and Fuel Technology, Mappin Street, Sheffield S1 3JD. Please quote ref. 77/7H.

LECTURES, MEETINGS AND COURSES



LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

M.Sc. Courses

Applications are invited for admission to the following 12-month full-time M.Sc. Courses, which commence in October each year.

- Analytical Chemistry and Instrumentation
- Medical Chemistry

Course (a) is recognised by the Science Research Council for the tenure of its Advanced Course Studentships, but a limited number of Scholarships are also available for Course (b). An extra preliminary year is available for candidates who do not meet the M.Sc. courses' direct entry requirements.

Descriptive leaflets and forms of application may be obtained from Administrative Officer, Department of Chemistry.

Loughborough Leicestershire

UNIVERSITY OF LEICESTER

M.Sc. COURSE IN MINING GEOLOGY AND MINERAL EXPLORATION

Graduates, and prospective graduates, in the earth sciences and mining engineering are invited to apply for admission in October 1974 to this one-year course which is designed both for those who wish to prepare for a career in these fields and should require a refresher course. The course is recognised by the National Environmental Research Council as suitable for the award of its advanced course studentships for which UK citizens are eligible to apply.

Full particulars and application forms may be obtained from the Registrar, quoting P97. Completed application forms should normally be returned before 31 March, 1974.

THE UNIVERSITY OF LEEDS

Department of Earth Sciences
M.Sc. COURSES IN
GEOCHEMISTRY
GEOPHYSICS
ENGINEERING GEOLOGY
AND GEOTECHNICS

Applications are invited for entry to the above postgraduate courses leading to the degree of M.Sc. by examination. The courses are for 12 months, beginning 1st October 1974 and they have been approved for the award of Advanced Course Studentships.

The entry requirements are a 1st or 2nd class degree in one of the appropriate subject, Chemistry or Earth Sciences, Geology or Physics, Mathematics, Civil Engineering or Mining, or a combined scheme of study which includes at least one of these subjects.

Students in Engineering Geology and Geotechnics is run jointly with the Departments of Civil Engineering and Mining and Mineral Sciences and the course in Geophysics is run in conjunction with the Department of Mining and Mineral Sciences. Further details and application forms can be obtained from the Secretary, Department of Earth Sciences, University of Leeds, Leeds LS2 9JT.

THE UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY

M.Sc. COURSE IN ADVANCED CHEMICAL ENGINEERING 1974-75

Options in (1) Separation Processes (2) Biochemical Engineering (3) Chemical Reaction Engineering

Applications for this MSc Course or for modules within the Course, are invited from graduate chemical engineers and other suitably qualified candidates.

The Course provides advanced training in the principles of design, selection and operation of plant and processes in the chemical process industry. The Options build upon a common core of courses in physical processes, fluid mechanics, mixing, optimisation and surface phenomena) to provide further advanced study in a particular area of interest to the student.

The Science Research Course has secured the status of an Advanced Course Studentship.

For further information write to Professor T. K. Ross, Department of Chemical Engineering, UMIST, Manchester, M60 1QD.

THE CITY UNIVERSITY

St John Street, London EC1V 4PB

THE GRESHAM LECTURES PHYSIC (Medical Science)

Three one-hour lectures will be given by Professor D. Slome, Head of the Department of Physics, Royal College of Surgeons of England, at 1.00 pm on FRIDAYS, 15th and 22nd February.

1. Mechanisms of Movements of the Alimentary Tract.
2. Digestion and its Disorders.
3. The Gaseous Reaction to Injury.

Admission free.
Details from Director of General Studies.

CRANFIELD Residential Short Course

STABILITY & CONTROL OF AIRCRAFT

11th-22nd March, 1974

The course will include lectures on the classical theory of stability and control, automatic control, influence of aeroelasticity and other current topics from the field.

Fee £140.

Further details from The Registrar (Short Course), Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL

Telephone Bedford 51551 (0234 - 815501) Ext. 284
Telex 525072.

UNIVERSITY COLLEGE LONDON

M.Sc. IN INFORMATION SCIENCE

This course in the University Faculty of Science is intended for those interested in academic teaching and/or research and development in Information Science.

The course runs for one calendar year and requires candidates to undertake written course work, take written examinations and to submit a dissertation on an approved experimental or theoretical project. The course is recognised by the UK Office for Scientific Research as a research award of a limited number of studentships.

Applicants are expected to have a good honours degree in one of the sciences and to have had at least one year's experience either of information work or of scientific research.

Further details and application forms can be obtained from Registrar, University College London, Gower St, WC1E 6BT.

UNIVERSITY OF LEICESTER

M.Sc. COURSE IN EXPERIMENTAL SPACE PHYSICS

Graduates, and prospective graduates, in Physics or Engineering are invited to apply for admission in October 1974 to this one-year course in Experimental Space Physics leading to the degree of M.Sc.

The course of lectures and laboratory work will provide a survey of current research in Space Physics and will include a comprehensive treatment of the techniques employed in space research. Some industrial studentships will be available and the course is also recognised by the Science Research Council as suitable for the award of its advanced course studentships.

Full particulars and application forms may be obtained from the Registrar, quoting P96.

THE UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY

M.Sc. IN POLYMER AND FIBRE SCIENCE

This MSc course, which was inaugurated in 1966, combines formal studies with a research investigation and is organised jointly by the Department of Polymer and Fibre Science in the Faculty of Technology (UMIST) and the Department of Chemistry in the Faculty of Science (University of Manchester). The studies are designed to enable a science graduate to obtain an advanced knowledge of the physics and chemistry of polymers. A parallel Diploma course, which omits the research content, is also available.

Applications are invited from Honours graduates (or holders of equivalent qualifications) in chemistry, physics, chemical engineering or a similar subject. Applicants will also be considered from persons expecting to graduate next June. The Science Faculty at Manchester has accepted the course as suitable for the tenure of its Advanced Course Studentships.

Applications and enquiries should be addressed to Professor Geoffrey Allen, Department of Chemistry, University of Manchester, M13 9PL, to Professor R. H. Peters, Department of Polymer and Fibre Science, UMIST, Manchester, M60 1QD.

UNIVERSITY OF BRISTOL

H. H. Wills Physics Laboratory

Applications are invited from candidates with, or expecting to graduate with, a good honours degree in Physics, Chemistry, Mechanical Engineering, Metallurgy, Ceramics or related subjects, for admission to a one year course of advanced study in research leading to the degree of

M.Sc. IN THE PHYSICS OF MATERIALS

The Course concerns the basic physical/mechanical mechanisms underlying the mechanical properties of solids of all kinds and is particularly appropriate for new graduates who intend to enter laboratories involved in materials research.

Candidates who successfully complete the Course may be considered, if they wish, as qualified to proceed to further research work in the laboratory as candidates for the degree of Ph.D.

Enquiries should be addressed to Professor F. C. Frank F.R.S., Director of the H.H. Wills Physics Laboratory, Tyndall Avenue, Bristol BS8 1TL.

ENGINEERING ACOUSTICS, NOISE AND VIBRATION

Full Time M.Sc. Course

Department of Mechanical Engineering, University of Nottingham. The course aims to provide holders of a good honours degree in Mechanical Engineering, Physics or Physics with a comprehensive knowledge of noise and vibration, enabling the successful student to execute and supervise experimental work in the laboratory, to interpret results, and design systems for noise and vibration isolation and control.

The programme of M.Sc. will be awarded on the results of written examinations and submitted projects. Projects based on industrial placements will be available. Full Time Course—1 year—commencing October, 1974, applications before 1st May, 1974.

Application forms are available from The Secretary, Nottingham University Environmental Studies Group, Industrial Building, University of Nottingham (Dept. NS), University Park, Nottingham NG7 2RD. Tel: 0532 560250. Extension 3392, information advice from Dr. J. S. B. Mather, extension 2623.

UNIVERSITY COLLEGE LONDON

M.Sc. DEGREE IN M.SEOLOGICAL SCIENCE

Applications are invited from graduates who wish to follow a College-based course of study leading to the M.Sc. degree of the University of London. Candidates will normally be expected to have research experience in the anatomy and neurophysiology. Students attend lectures, practical classes, seminars and tutorials on the anatomy, microscopic structure and physiology of the nervous system, and participate in a research project under the guidance of a member of staff and prepare each week a written report. The course begins on 30 September 1974 and lasts for one calendar year. M.R.C. postgraduate training awards may be available for successful applicants. Application forms may be obtained from Registrar (M.S.L.), University College London, Gower Street, WC1E 6BT, and completed applications should be returned to him by 11 March 1974.

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DATLINE (NS),
23 Abingdon Road,
London W.8.

BIOFEEDBACK Research & Experimentation. Psychological Laboratory (private, professional, non-profit making consortium). Phone: Hon Sec 01-229-4104 (W to F only).

UPOB and DE HYNEN—serious UPOB (University of Professional Operators) conducted in GB. Details from: Research Director, Newshapel Ob-servatory, Bufoa Dept. 51, Stoke-on-Trent.

Ariadne

Will the oil become scarcer or dearer—or both? How you plan your lifestyle from now on depends on such predictions. I should not be surprised to see enterprising manufacturers moving pretty smartly into the solar panel market, starting perhaps with new houses and extending later to "kits" for modifying older ones. There may be problems for local authorities when the trendier suburbs start applying for permission to set up windmills but before that the principle will probably be tried out by the well-heeled in the Welsh hills, or those Shetlanders who manage to sell their land to the oil companies. Water wheels should make something of a comeback in those parts of the island where hitherto people have complained of the everlasting rain. In the cities where most of us live there will be no opportunity (nor inclination) to indulge in those foibles. Instead the electricity bill and the cost of running the car will become more significant components of the unions' wage demand. Unless (let's plunge wholeheartedly into a world of fantasy) some political grouping emerges to educate us in such matters. "Switch Off Something" is a slogan of the moment. Perhaps, as in the case of the electric carving knife, we should refrain, when the immediate crisis is over, from switching it on again. The trouble is of course that the status quo, though somewhat dented, has our imaginations in a paralysing grip. It will take more than the present shortfall in oil and coal fundamentally to alter our ways of looking at the future. Still, I wish more people were trying to do it.

DREADCO should be interested to hear from Dr Isay Balinkin, a physicist at the University of Cincinnati, who has proposed that, by slowing down the world just a little, we might provide ourselves with a handy energy source. (By "just a little" Dr Balinkin means about a second a year, though I think he underestimates how much some people would miss it.) The trick, he says, is to find a device on Earth which moves independently of the planet's motion, drive the device with the Earth's spin and tap power from it. A pendulum, for instance, moving through a magnetic field would make electricity. If you could build one big enough—and it were driven by the Earth's rotation in the way that a clock's escapement mechanism transfers the gravitational energy to a pendulum and helps it to overcome friction. Though Dr Balinkin is making the point only to start his colleagues thinking about other sources of energy besides the fossil fuel sort and is well aware of the mind-boggling problems for the engineer trying to make a pendulum that size, I shouldn't be surprised to hear of the idea sparking off something more practical. The Arabs are crazy if they believe they have got the American technologists over a barrel.

The following conversation took place last week between a colleague and his seven-year-old son:

"What did you do in school today?"

"We learned about air."

"What did you learn?"

"That if you put your finger over one end of a straw and suck the other end, the straw collapses. Only we had plastic straws, so they didn't."

"And what did that show?"

"That straws can't live without air."

Serious as the balance of payments crisis may be, all is not lost. Jamco Plastics, Bedford, has just landed a £100 000 contract to supply battery-operated yo-yos to the United States. So popular are these indispensable devices that Jamco has some £2 million worth of inquiries and orders from as far away as Canada, Australia and Barbados.

My ionomobile friend Daedalus is bored with ordinary electricity—negative electrons moving through a positive metallic lattice—and is inventing new sorts. He points out that ion-exchange resins (used in e.g. water-softeners) are like metals in that one set of ions is quite mobile while the oppositely charged set is firmly bound to the open molecular lattice of the resin. So they should be conductive by movement of the mobile ions: except that ordinary instruments would reveal nothing because the ions could not enter their copper wire. However, an all-resin

circuit, driven from a resin-wound dynamo, would be perfectly feasible. It could also be driven by a neat battery whose dissolved ions would directly leave and enter the resin electrodes. As many different sorts of electricity could be made as there are mobile ions; some would be mutually exclusive (e.g. big ions could not enter a small-apertured resin lattice). Ionic currents could sometimes interact with ordinary electricity in intriguing ways. Thus if sodium ions flowed one way through a resin while electrons flowed the other way through a carbon contact, they would combine at the join giving out sodium light and forming sodium metal in a sort of solid electrolysis. This neat lamp would also act as an accurate electronic memory; for on reversing the potential, current could flow until the charged "banked" as deposited sodium had been exactly withdrawn and the metal had all been decomposed again. Many other cunning devices must be hiding in the rich field of multiple electricities—ionic transistors, inter-electric transducers, chemical sensors and the like. In particular, absorption by the resin of molecules of just the right shape to block its molecular pores would make a sensitive electrical "nose" working on the same principle as the real thing. Indeed, Daedalus hopes that since nerves use ionic rather than electronic current, ionic currents when fed into us will produce a whole new range of sensations making possible very intimate man-machine interactions: whereas traditional electronic current is merely shockingly unpleasant.



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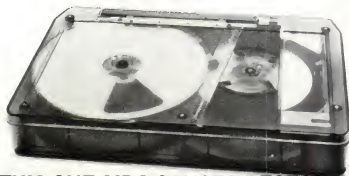
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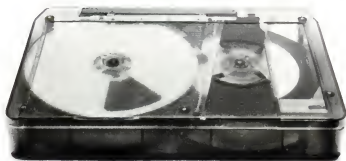
Slotted into a special tape deck, it can be played through an ordinary household television.

It's called the Sony U-matic.

And it means there's now a television system that lets you control the subject, time, viewing frequency and audience.

Think what your company could do with that.

SONY.



THIS ONE EXPLAINS ALL THE OTHERS.